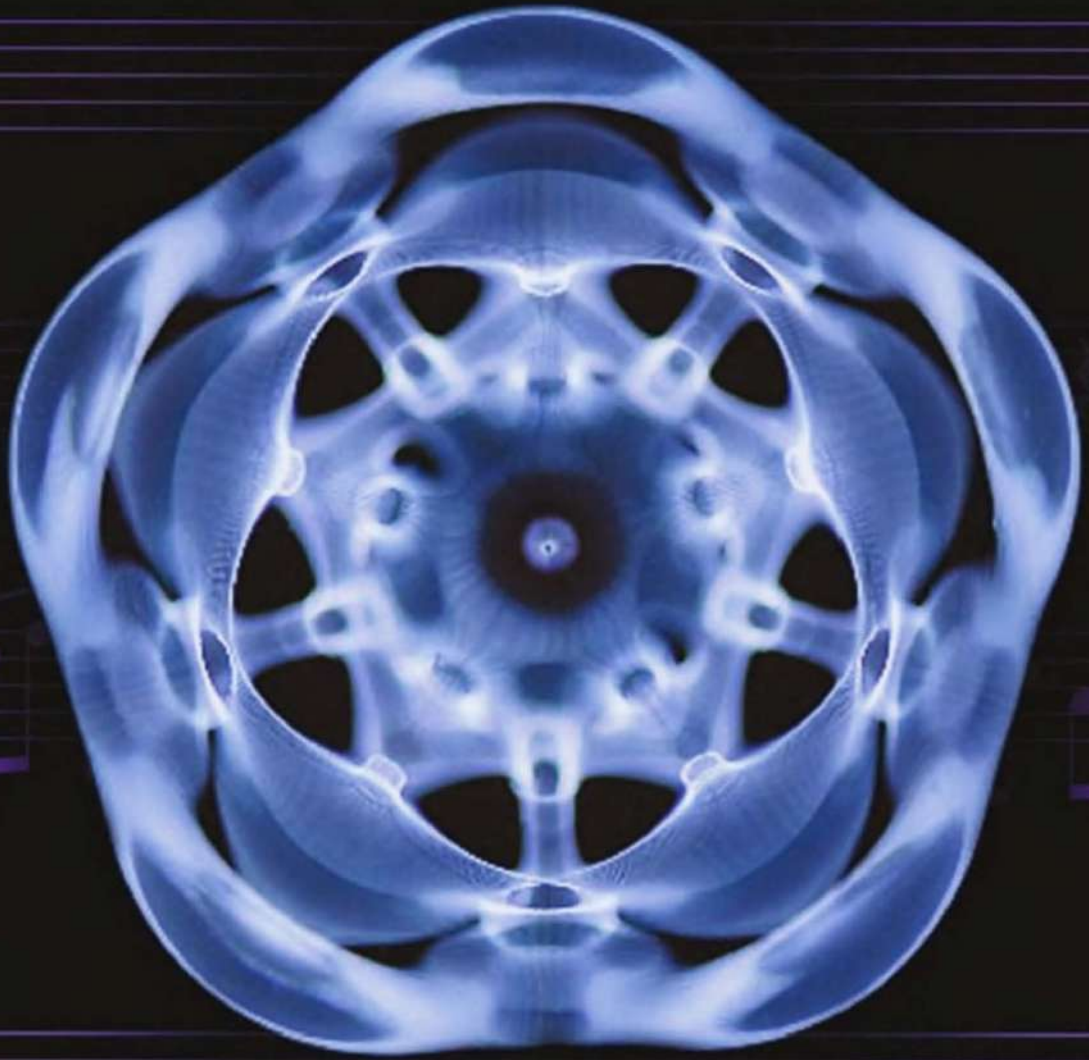
UPDATED SECOND EDITION



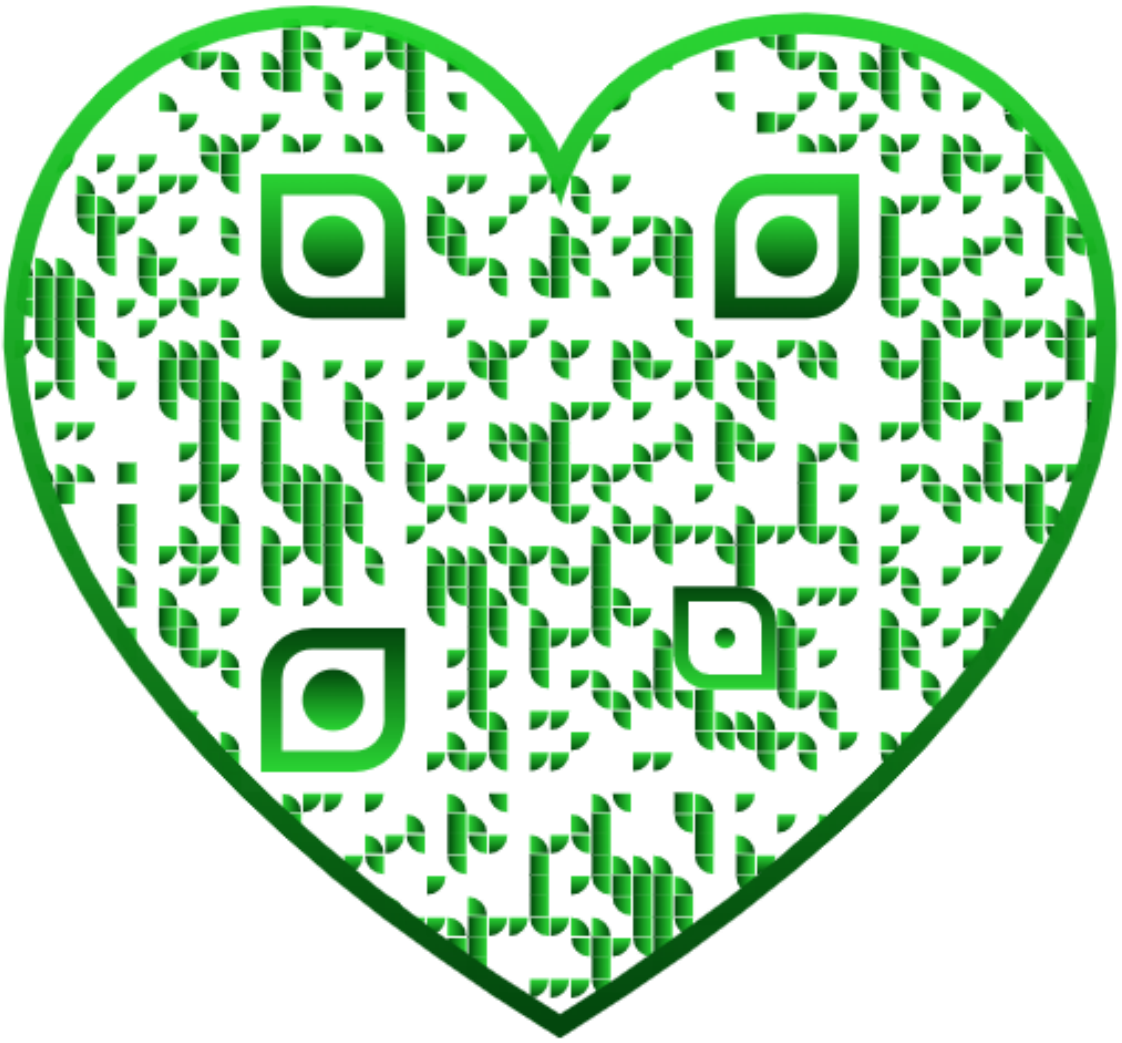
The POWER OF SOUND

How to Be Healthy and Productive Using Music and Sound

INCLUDES 75-MINUTE CD TO ENHANCE LEARNING & WELLNESS

CD Included

JOSHUA LEEDS

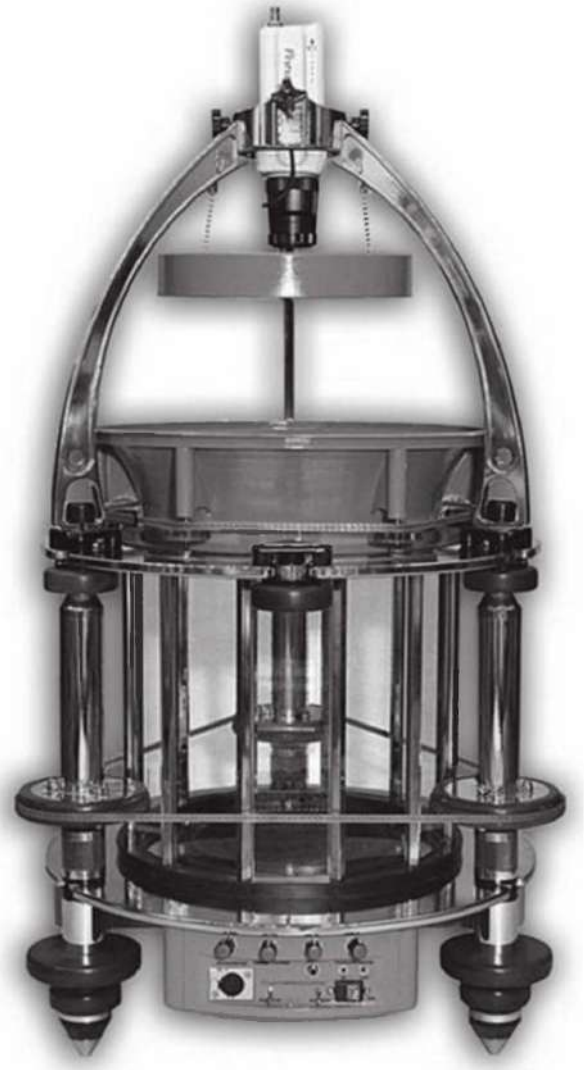


"Joshua Leeds points to the future for the entire music community—musicians, producers, engineers, composers, and businesspeople. I applaud his generosity in sharing the psychoacoustic techniques he has developed and utilized to great effect. In combining music and science, Leeds has achieved a dramatic advance in the use of music and sound for empowerment and change."

JOE HARNELL, GRAMMY AWARD–WINNING COMPOSER,
PIANIST, AND AUTHOR OF *COUNTERPOINT:*
THE JOURNEY OF A MUSIC MAN

ABOUT THE COVER IMAGE

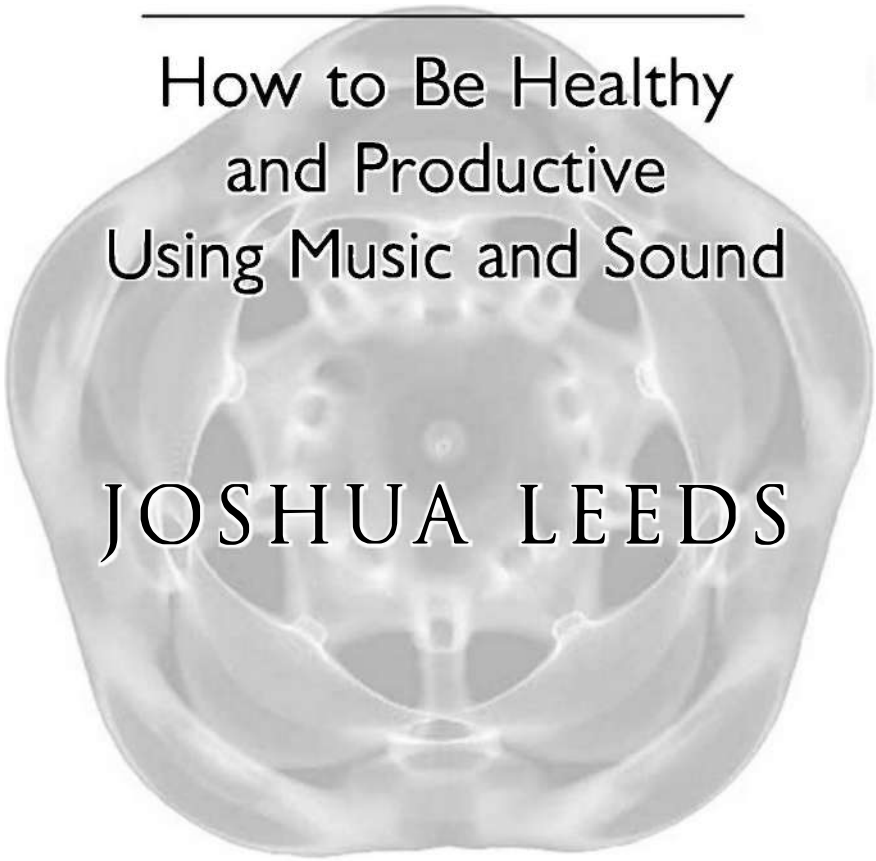
British inventor John Stuart Reid studies patterns manifested by sound when applied to liquids or loose particles. In collaboration with American design engineer Erik Larson, Reid created an extraordinary instrument called the *CymaScope,* shown below, that makes sounds visible.



A beautiful CymaScope image, known as a *CymaGlyph,* is seen on the cover of this book. This near-perfect CymaGlyph is a pure 22.2 Hz tone. The nested pentagonal arrays, imbedded in the natural geometry of the tone, portray the golden mean ratio. (See p. 216 for an interview with John Reid.)

THE POWER OF SOUND

How to Be Healthy and Productive Using Music and Sound



JOSHUA LEEDS

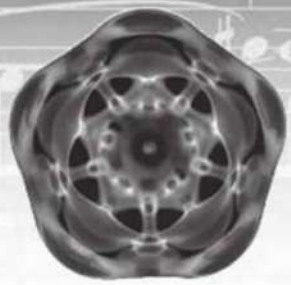
Healing Arts Press
Rochester, Vermont • Toronto, Canada

This 2010 revised edition of *The Power of Sound*
has two companion resources:

1. ThePowerOfSound.com is both an adjunct and continuation of the pages that compose this book. Look for this insignia:

. In today's digital world, where information so quickly transpires, we will use this companion website to update resources, research, and significant events. The symbol

will also be used to signify deeper online discussion of specific topics.
2. The CD at the back of the book contains exemplary selections of music psychoacoustically designed and produced by Joshua Leeds. Look for this insignia: .



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And finally, to Sheila Smith Allen—my deepest appreciation for your rock-steady enthusiasm and support for intentional soundwork in all its manifestations. A more delightful and dedicated colleague would be difficult to find.

Thank you all for gracing the pages of this book with your generous wisdom, fertile imaginations, and loving heartspace.

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PREFACE

2010 and Moving Forward— The Decade of Sound!

What an exhilarating thing . . .

For the last year, I've been writing this revised edition of *The Power of Sound*—googling, reading, comparing, interviewing, compiling, writing, and editing—all in the service of understanding the current state of *sound-work* in America. I've discovered that not only is the community of intentional music and sound alive and well, but it has never been better! Why? Because this field is poised to come into its own, to take a seat at the table of respected modalities of positive effect.

What does that mean, and why now?

I believe that 2010 begins *the decade of sound.* Those of us who are called to travel in this currency of resonance are actually inadvertent hitchhikers on the backs of neuroscience. Beginning in the early 1990s, with the advent of high-tech images produced through new techniques such as Magnetic Resonance Imaging (MRI), scientists were able to look at brain function in real time in a way never before seen. As more of these extraordinary machines became available, varied aspects of neurologic perception were examined. Music, of course, would be one of the elements of study. How could it not be?

As researchers began to explore how and why sound and music affect us the way they do, cross-culturally and generationally, scientists discovered

that the cognitive interpretation of music is so complex, and uses so many different parts of the brain, that the study of musical neuroscience could actually provide a new model for the study of cognition in general. How lucky for us in this field of soundwork! Our culture, at all levels, will now have an empirical understanding of what wise men and healing women have known forever: Sound, and music itself—the most glorious sculpting of sound frequencies—are gifts like water and air, flowers and children laughing. We could not live without this presence that goes so beyond words, into the limbic system of pure feeling and emotional sustenance.

As I write, there is a research project underway in Spain. A team is looking at the influence of music on the behavior of neural stem cells. This concept is breathtaking. The study of stem cells is such leading-edge research . . . and already, intrepid music researchers are looking at whether music can be used to stimulate stem cell growth. Neysa Navarro, the primary researcher, says:

> The idea that music has a therapeutic function is going through a rapid transformation based on research done in neuroscience. Scientists are attempting to clarify its neurobiological basis and finding that music has an influence on learning, animal behaviour, or brain functions in animals. It is believed that by knowing how music affects animals, this will provide an important insight into how music could also affect humans.
>
> Based on a reliable experimental design, the preliminary results of our research have shown that music seems to have a direct and specific effect on cellular behavior which is made clear by cellular survival activation as well as the reproduction and neurogenesis mechanisms.*

Wouldn't you know it, music once again encourages reproduction . . . and now, the formation and development of nerve cells!

It is a very good time to be in this field of soundwork. Because of the new understandings provided by the emerging field of music neuroscience, lines become blurred between music and sound therapy, therapeutic bedside musicians and expressive arts therapists, and research of Music and Medicine

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* TPOS The abstract of the study, *The Influence of Music on the Behavior of Neural Stem Cells,* can be found online at ThePowerOfSound.com/NeuralStem.

Professionals in these fields realize that this is a timely opportunity to forge new networks, much as neural stem cells do, allowing for regeneration and renewal. The meeting tents are forming and our field is alive and well poised and ready to rock! Van Morrison even wrote a song, released in 2008, entitled, "That's Entrainment." I guess we've arrived.

I welcome you and hope that something in this book, now twice written, inspires you to greatness. What else is there?

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INTRODUCTION

What is it about *sound* that captures your interest?

This thought-provoking question challenged me to explore twenty-five years of devotion to the world of soundwork. My introspection brought to mind the renewal process of a marriage vow.

- *If we could do it all over again, would we?*
- *After all this time, how shall we continue?*
- *What serves now, given that we're different than before?*

When I muse on this question of interest, I'm taken by the unparalleled uniqueness of this frequency medium and our funny ears—the organs intended for our most comprehensive aural experience. No wonder this vibrating energy force captures our attention. We have a dual relationship with sound—different from our relationship with sight, smell, or taste. Not only can we take in sound, but we can also make it—however we want! No rules, completely individual. Our sounds: the ones we make or with which we choose to surround ourselves.

What also captures my interest about sound are these five factors, especially true in the second decade of the twenty-first century:

1. *Cutting edge.* Soundwork provides an opportunity to work in a field that is still forming. This means that there is great freedom in exploration and innovation. All of the combinations and liaisons have not been solidified.
2. *Varied playing fields.* Sound is a frequency that is slow enough to mold in many ways. It is the clay from which we create music, universally adored. Sound, and our perception of it, is the medium from which we also create words, the currency of interaction.
3. *Living creators.* While we've lost three great soundwork pioneers

between 1995 and 2010,* the pool is deep with living method creators. Our having access to active and vital soundwork innovators—many of whom we can find through the Internet—speaks to the creative times in which we live and the opportunities for a collaborative community.

4. *Right place, right time.* Between neuroscience and high technology, sound is a darling at the ball. From neurocognitive studies to national security research, sound waves are of great usefulness and interest to a variety of science professionals.
5. *Gateway to other perceptual organs.* With the understanding of sound, why stop there? What's the bigger sandbox of related sensory organs that perceive light, taste, aroma, and touch? How do they interrelate, and how can we combine the intentional use of sound with other senses?

To answer the questions I posed at the beginning of this introduction:

- With these fertile grounds, how could I not redouble my efforts of a life in sound?
- Now, however, I can take advantage of neuroscience discoveries and high technologies to create and globally distribute my work.
- What serves now? Let's take a look at twenty-first-century soundwork!

IN SEARCH OF CUTTING SOUNDWORK EDGES

Surveying anew the field of soundwork—ten years after *The Power of Sound* was first written—provides us with a snapshot of our field's evolution and, with imaginative foresight, allows us to predict what lies ahead.

One circumstance that is different from that of ten years ago, when I spent weeks in university libraries researching clinical studies, is my use of Internet search engines. For example, each day, eight communications arrive from Google Alerts into my e-mail inbox.†

My topics include sound therapy, sound healing, music therapy, sound research, and music research. A sampling, just from today, runs the gamut:

---

*Robert Monroe, Alfred Tomatis, Peter Guy Manners

†This free service allows anyone to request notification of a self-selected topic's emergence anywhere on the Web.

for $6,910, you can own the "best" headphone sound system; there is also a new Italian research study delineating the effects of music volume levels on the cardiovascular system.

What I see on Google in 2010 fills the full spectrum of soundwork—from videos of grassroots toners and chanters with Tibetan bowls and didgeridoos to interviews with imaginative academics who have completed quantifiable applied research projects. This vibrant, wide spectrum is not unlike the scene found ten years ago. However, this is an example of what has changed: Then, handmade metal bowls provided the most mellifluous tones for the listener. Today, crystal singing bowls made of pure crushed quartz are available—tuned to the exact frequencies you desire. As technology continues its relentless incursion into all things biological, neuroscience and music research intersect in ways unforeseen even just a decade ago. One of the most popular iPhone apps is called Ocarina. Blowing into your smartphone and having it sound like a Peruvian instrument is great. But what is breathtaking is watching a real-time image of a spinning globe, showing location and broadcasting melodies from other iPhone ocarina players, transmiting from the palm of their hands—no wires attached!

Dr. Daniel Levitin could be a poster child for the evolution of music research. He now runs the Laboratory for Music Perception, Cognition, and Expertise at McGill University. Before becoming a research neuroscientist, he was an award-winning record producer and professional saxophone player. His recent books, *This Is Your Brain on Music—The Science of a Human Obsession* (2006) and *The World in Six Songs—How the Musical Brain Created Human Nature* (2008), are exciting examples of the depth of soundwork study today. Drawing from the fields of neuroscience, evolutionary biology, social anthropology, and musicology, he seeks to examine the brain's evolution through mankind's relationship with music, and he posits that music itself may well have been essential to our development as a species.

In 1997, Don Campbell published *The Mozart Effect*[1] to great popular acclaim. My esteemed colleague wrote about the extraordinary theories of Dr. Alfred Tomatis (1920–2001) and the evolution of his practices in healing, learning, and creativity.

The Mozart Effect also included references to the groundbreaking (but subsequently nonreproducible) studies headed by University of California, Irvine physicist Gordon L. Shaw (1940–2007) on the effect of listening to specific Mozart pieces prior to college test taking. Both Campbell and,

inadvertently, Shaw were taken to task by the scientific community and media—not for their intentionality, but for the lack of verifiable results. What a difference a few years can make. Flash forward just nine years to Mozart's playground . . .

In 2006 and 2008, a conference series titled *Mozart & Science* was held near Vienna, Austria, addressing interdisciplinary research on the effects of music on the brain. Researchers from the fields of biology, chemistry, mathematics, education, psychology, sociology, and medicine all contributed to assuage this unabated thirst for greater understanding about music and its effects. The 2009 book titled *Music that works* chronicles many of the presentations from the first conference. Dr. Roland Haas, the book's coeditor and president of the sponsoring organization, International Music and Art Research Association Austria (IMARAA), writes:

> The bridges being built between chronobiology and neuropsychology, between music therapy and neurology, between public health studies and mirror neuron research, as well as between musical education and research into emotions struck us as being potentially very valuable starting points toward a deeper understanding of more complex aspects of the psychophysiological effects of music on listeners.[2]

In 2011, Don Campbell and coauthor Alex Doman will publish *Healing at the Speed of Sound*, an exhaustive survey of thousands of research studies.

SO, WHAT'S NEW?

After a year of interviews and literature surveys, I can report that the music research that began five hundred years ago* continues at a very enthusiastic pace. While it is impossible to plant a flag on a rapidly moving object, in this 2010 revision of *The Power of Sound*, I've attempted to summarize the continuum of twenty-first-century soundwork. My intention has been to accurately inform and inspire. Any omissions are unintended, and respectful apologies offered in advance.

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*The interrelationship of rhythms in biological systems and the pulse beats of music was first described by J. Struthius (1510–1568), a Polish physician, professor, and medical writer whose work influenced English physician William Harvey in his groundbreaking work on the circulation of the blood.

- Vibroacoustics continues to develop, with great advances in cymatics. The direct application of frequencies now moves from the body to agriculture with great promise.
- Music in hospitals becomes far more conscious, with live and prerecorded audio programs abounding.
- The number of available sound media (how we send, receive, and make sound) continues to expand exponentially through the use of high technology. There is great therapeutic access through the mobile Internet (iPhone, iPad, iPod), music programs for hospitals and commercial outlets are downloaded from satellites, and noise cancellation techniques look promising for the treatment of tinnitus!
- The effects of sound on animals can be used in therapeutic ways.
- Research continues to uncover how tone, tempo, and pattern can serve or ail us.
- Rhythmic Auditory Stimulation is a successful method being used for stroke recovery.
- Otoacoustic emissions, sounds coming out *from* the ear, may become a security identifier and provide a key to the diagnosis of missing frequencies in the body.
- Human BioAcoustic Biology asserts that the human voice is a mathematical matrix of predictable frequency relationships that represent the structural, biochemical, and emotional aspects of the body, and that wellness can be restored with the introduction of the balancing frequencies.
- Under the SAMA tent: the Sound and Music Alliance becomes soundwork's first U.S.-based professional association—complete with extensive ethical codes and professional membership designations—launching intentional soundwork and music toward a higher degree of awareness, cultural acceptance, and interdisciplinary collaboration.

Two other cutting-edge ideas are questioning the possibility of the following:

- Can swirling rhythmic patterns be used for autism (Rhythmic Entrainment Intervention)?
- Can application-specific musical compositions be created from brain waves?

The trajectory of intentional sound and music is focused and strong.

WHY STUDY SOUND?

Our basic survival depends on legs for running, fingers for gathering, and sexual organs for reproducing, along with that most amazing computer that coordinates millions of messages every second of every day—the brain.

In addition, our four sensory organs—the eyes, nose, mouth, and ears—inform the brain of surrounding conditions. The seven orifices of the head sample different octaves of frequency—light, aroma, taste, and sound. With this information, the brain adjusts physiological mechanisms to function optimally. Am I safe? asks the reptilian brain. With the primary question of survival addressed, this ancient brain relaxes like a lazy lizard in the sun, allowing us to focus on secondary aesthetic considerations: Does this light feel good? Do I prefer these smells? Yum . . . got any more chocolate? Turn up that music!

Once the determinations of safety and personal preference are established, our attention turns to utility. This third tier of sensory perception involves conscious employment of the elements. The creation of tools distinguishes human beings from other animals. People know how to put things to work. In this context, frequencies of light, smell, taste, and sound can be perceived as utilities. Through heightened awareness and specific application, these frequencies become highly refined tools for the enhancement of human function. *How can we use these elements for a better life?* Thomas Edison asked about light. In the hands of a chef, taste becomes elevated to a fine art. Aromatherapists have built an industry on the efficacy of fragrance. The ways that sound serves us run the gamut from background ambience to a potent surgical replacement.

Although all of our sensory organs and their frequencies deserve exploration, *The Power of Sound* focuses on the domain of sound. Humans cannot manufacture light or taste directly, and our repertoire of creative odors is quite limited. We can, however, *make* sound. Not only can we perceive it, but we can also create it: music, laughter, and words turn sound into a friendly, practical, and interactive medium.

As a child I did what comes naturally; I made a lot of noise. My early fascination with sound was channeled into music. Since then, through participation in elementary school orchestras and teenage rock bands, through studying classical guitar and piano in my twenties and jazz in my thirties, through engaging in conservatory explorations of classical composition and orchestration in my forties, I've honed that primal instinct to create and mold

sound. As a composer drawn to the essence of music, I experience sound as the clay from which musical sculpture evolves. Although music comprises sound, sound is not always musical. *What is sound? What does it do* to *us? What can it do* for *us?* These are questions I propose to answer.

Psychoacoustics is the study of the effect of music and sound on the nervous system. Using extensive databases of psychoacoustic research, *The Power of Sound* explains *why* we hear and feel sound, and how we can use it purposefully to enhance our lives.

To explore the many applications of sound, I will discuss the entire spectrum—heard and unheard. Their mutual substance is *vibration*, a rapid rhythmic motion back and forth, and *frequency*, the periodic speed at which an object vibrates. *Resonance* refers to the frequency at which an object most naturally vibrates. These sonic identifiers are our basic building blocks.

Consider the following: anything that moves has a vibration. Though invisible, every aspect of our material world at the atomic level moves constantly. Wherever there is motion, there is frequency. Though inaudible at times, all frequencies make a sound. All sounds resonate and can affect one another. In the spectrum of sound—from the movement of atomic particles to the sensory phenomenon we call music—there is a chain of vibration:

- All atomic matter vibrates.
- Frequency is the speed at which matter vibrates.
- The frequency of vibration creates sound (sometimes inaudible).
- Sounds can be molded into music.

This chain explains the omnipresence of sound.

PSYCHOACOUSTICS

Psychoacoustics is the study of the perception of sound. This includes how we listen, our psychological responses, and the physiological impact of music and sound on the human nervous system. In the realm of psychoacoustics, the terms *music, sound, frequency,* and *vibration* are essentially interchangeable, because they are different approximations of the same essence. The study of psychoacoustics dissects the listening experience.

Traditionally, *psychoacoustics* is broadly defined as "pertaining to the perception of sound and the production of speech." The abundant research that has been done in the field has focused primarily on the exploration of speech

and of the psychological effects of music therapy. Currently, however, there is renewed interest in sound as vibration.

An important distinction is the difference between a *psychological* and a *neurological* perception. A song or melody associated with childhood, a teenage romance, or some peak emotional experience creates a memory-based psychological reaction. There is also a *physiological* response to sounds. Slightly detuned tones can cause brain waves to speed up or slow down, for instance. Additionally, sound tracks that are filtered and gated—this is a sophisticated engineering process—create a random sonic event. This triggers an active listening response and thus tonifies the auditory mechanism, including the tiny muscles of the middle ear. As a result, sounds are perceived more accurately, and speech and communication skills improve. While a psychological response may occur with filtered and gated sounds, or detuned tones, the primary effect is physiological, or neurological, in nature.

Research on the neurological component of sound is currently attracting many to the field of psychoacoustics. A growing school of thought—based on the teachings of the French doctor Alfred Tomatis—values the examination of both neurological and psychological effects of resonance and frequencies on the human body.

Thanks to the groundbreaking findings of Tomatis, we have come to understand the extraordinary power of the ear. In addition to its critical functions of communication and balance, the ear's primary purpose is to recycle sound and so recharge our inner batteries. According to Tomatis, the ear's first function in utero is to govern the growth of the rest of the physical organism. After birth, sound is to the nervous system what food is to our physical bodies: food provides nourishment at the cellular level of the organism, and sound feeds us the electrical impulses that charge the neocortex. I will discuss the theories and practices of Tomatis at length; indeed, psychoacoustics cannot be described at all without reference to the man known as the Einstein of the ear.

HEARING AND LISTENING LOSS—PLAYING WITH FIRE

My overarching theme in *The Power of Sound* is the tremendous influence that sound and hearing have over human functionality. But what happens if our ability to hear is diminished? In Western culture, auditory dysfunction is growing at an unprecedented rate, due mainly to noise and stress. Our

delicate auditory mechanism serves as a barometer of physiological status as well as of our emotional state of mind. The result of auditory malfunction is more than a diminution of hearing.

A weakened auditory system endangers *auditory sequential processing* This function affects short-term memory—the critical ability to link pieces of auditory information.

Auditory sequential processing is critically affected by *auditory tonal processing*. Difficulty interpreting tone may create sequential processing issues. The neurodevelopmental specialist Robert J. Doman Jr. believes that the inability to focus our listening—a symptom of auditory dysfunction—diminishes communication, language, and attention skills in adults and children. Is it a coincidence that the explosive growth in learning disabilities—a sequential processing issue—is paralleled by an accelerating rate of food allergies that cause children's ear infections?

According to Tomatis, Doman, and other pioneers, sound is a vital stimulant, a "nutrient" for the nervous system. Consequently, weakened auditory function depletes a major fuel system for the brain.

Of the many causes of hearing and listening impairment, I will discuss two primary forms. *Noise-induced hearing loss* (NIHL) contributes to approximately 35 percent of all hearing loss in America.[3] Too many protracted loud sounds damage the inner ear. NIHL is physiological damage: the delicate cilia hair cells cannot be repaired.

In addition, stress can impede the active absorption of sound. I label this phenomenon *stress-induced auditory dysfunction* (SIAD). According to Billie Thompson, a leading Tomatis adherent and an expert in auditory impairment, "Poor listening can begin at any age and for any number of reasons. It might result from a health problem, an accident, a major lifestyle disruption, or from stress."[4] Among the symptoms of a degraded auditory function, says Doman, are "disorganized neurological function—affecting the ability to perceive, assimilate, process, and retrieve data—and emotional overreactivity."[5]

Additionally, when we can no longer tolerate a parent, sibling, spouse, boss, or the like, we begin to "shut down" the mechanism of the middle ear. This has the effect of eliminating the vocal frequencies we reject. Such psychological muting becomes a reflexive and subconscious action. As we shut out sounds, however, we also decrease the audio frequency spectrum.

The net effect of hearing loss, be it noise or stress induced, is that a vital energy source for the brain and nervous system is diminished. Additionally,

the degradation of auditory function can result in muddled thinking and out-of-balance emotions.

Stress-induced auditory dysfunction affects the muscles in the middle ear. (The tensor tympani and stapedius muscles become flaccid; this causes the ossicles—the three tiny bones of the middle ear—to work less efficiently in protecting the eardrum from excessive sound and in transmitting a full spectrum of sound.) This form of hearing and listening loss can be addressed, to differing degrees, with sound stimulation auditory retraining programs. While inner-ear damage from noise cannot be repaired, auditory retraining of the middle ear allows for better use of what hearing remains.

Stress-induced auditory dysfunction is the psychological equivalent of physiologically-based NIHL. Our current, growing awareness of SIAD has evolved from the work of Tomatis, Doman, and others over the last four decades. Most health care professionals know little about SIAD. Those who recognize and treat the auditory results of stress are reluctant to discuss it due to a dearth of research data. However, many practitioners in neurodevelopment, psychology, psychiatry, speech and language, and occupational therapy acknowledge the SIAD they see repeatedly in their patients. Is the troubling rise in prescriptions of antidepressants and other psychiatric drugs for children and adults masking problems that could be adjusted through remediation of the ear? The auditory response to stress deserves discussion and research. Clinical observations abound, but the neurobiological underpinnings are lacking.

SONIC RESPONSIBILITY

What can be done about this epidemic in noise- and stress-induced auditory dysfunction? you might ask. Begin by establishing a new sound awareness. Assert your sonic rights. Take appropriate precautions and protect your ears. Become proactive in auditory health and restoration. Learn to create sound space conducive to the needs of your nervous system.

We all have the same equipment—two ears. The conscious use of sound comes down to understanding how sound affects us. Then we can apply positive psychoacoustic principles to our situations and environments. This is sonic responsibility.

Sound can be used as a tool to destress, improve mental productivity, accelerate learning, minimize pain, and facilitate healing. It is time to take back the space around our ears, to learn to govern our sonic environments

or create new and better ones. With the information presented here, you will be able to take charge responsibly, according to your individual needs.

WHAT THIS BOOK CAN TELL YOU

The Power of Sound is divided into three parts.

Part 1 examines the physics of sound and the mechanics of hearing. It also discusses resonance, entrainment, and the groundbreaking work of Alfred Tomatis.

Part 2 explores sound awareness—for people and animals—and looks at current research into the personal applications of intentional music and sound.

Part 3 is a professional's guide to soundwork techniques and includes an exploration of therapeutic uses of sound, sonic neurotechnologies, applied psychoacoustics for health care practitioners, explanations of psychoacoustic techniques in music production, and an introduction to soundwork's first professional association, the Sound and Music Alliance (SAMA).

The enclosed CD, *Music for The Power of Sound,* is composed of specially orchestrated classical music performed by the award-winning players of the Arcangelos Chamber Ensemble and the Apollo Chamber Ensemble. These beautiful pieces are indicators of the music of the future—intentional soundscapes for the enhancement of human function. Techniques used in these recordings are discussed in chapter 18, "The Anatomy of Psychoacoustic Music Creation."

TPOS *ThePowerOfSound.com:* The conversation continues and is updating online! *The Power of Sound* doesn't stop at the end of this book! This is a big world where so much transpires quickly. Use the Internet and bookmark ThePowerOfSound.com, where updated resources, research, references, and significant events will be posted as they become available. The symbol TPOS will be used throughout the book to signify deeper detail at this book's companion website.

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My goal is that *The Power of Sound* will serve as an introduction for the uninitiated and a further exploration for those already called to a deeper listening. It is my hope that this revised edition will be of great value to health care professionals, educators, musicians, and others who adore music and respect The Power of Sound.

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PART ONE

Sound

CHAPTER 1

What Is Sound?

Sound is vibratory energy. Sound touches us and influences our emotions like no other source of input or expression. It is the stuff of tone and timbre, silence and noise. It is a frequency of vibration that we audibly hear between 20 and 20,000 Hz. Traveling through the air at 770 miles per hour (its exact speed depends on temperature, humidity, and wind), sound moves almost a million times slower than the speed of light.[1] We perceive it primarily through our ears, where it is transformed into electrochemical impulses sent to the brain. It is also perceived through the skin. Like air and water, sound is ubiquitous. It can be a great thing . . . or it can really be a problem.

Ancient cultures knew about the power of sound long before the term *science* was coined. The spiritually wise men of India knew that the world *is* sound. From India's Vedic scriptures comes the term ***nada brahman,*** "the primal sound of being" or "being itself." Even four thousand years ago, India's scholars and religious leaders understood that we live in a state of vibration from which sound derives and on which sound has profound influences.[2]

Philosophers and prophets of old shared a common belief in the divine origin and nature of sound. In ancient philosophies and religions, sound (vibration) is the lead character in creation myths. The genesis of the universe—or, thinking locally, our planet Earth—is ascribed to the "Word" or the "One Sound." Cutting across historical, religious, and political lines, Egyptians, Hebrews, Native Americans, Celts, Chinese, and Christians all have spoken of sound as a divine principle.[3]

The roots of this belief in the power of sound can be found in the ancient cultures of the Ethiopians, Hopi, and Aborigines, as well as the temples of

Greece and Rome. Many of the musical philosophies of Pythagoras have withstood the test of time. In *The Secret Power of Music,* however, David Tame states, "Almost three thousand years before the birth of Christ, at a time when the music of European man may have amounted to no more than the beating of bones on hollow logs, the people of China were already in possession of the most complex and fascinating philosophy of music of which we know today."

The Chinese dynasties compared music with a force of nature and held it in that level of awe. "The Chinese understood the power within music to be a free energy, which man could use or misuse according to his own free will, Tame states."[4] The rulers and their philosophers believed that in order for their citizens not to misuse music—and for all to benefit from its optimally beneficent use—only the "correct" music could be played. Beyond entertainment, Chinese emperors believed moral influence was the major effect of music that they needed to control. And revere and harness the power of sound they did, for four and a half millennia, until the Ch'ing dynasty (1644–1912).[5]

Worldwide, powerful shamans cured disease and mental anguish by coaxing evil spirits into leaving their victims through the power of chanting. Today entire villages, from Africa to Alabama to the Arctic, continue to drum, sing, or dance themselves into states of spiritual ecstasy.

The entire planet vibrates to the rhythms and sounds of music. No matter how primitive or advanced, music plays an inclusive and vital role in every nation. It is an inescapable part of life: of spiritual ceremonies, social celebrations, child rearing, armies marching off to war, initiations, funerals, harvests, and feast days.

Music strikes a chord within that cannot be expressed easily in words. It soothes and excites us. We resonate with its rhythms, harmonies, and tones. It *feels* good. What is so deeply familiar about tone and rhythm that we can close our eyes and drift away, trusting we are safe in the timelessness of music's embrace?

I believe the answer to this question lies with resonance and sympathetic vibration.

VIBRATION AND RESONANCE

Virtually everything on Earth vibrates. The planet itself vibrates. All matter consists of atomic material: molecules, atoms, electrons, protons, neutrons, and subatomic particles. Each atom consists of a nucleus surrounded

by electrons, revolving at the speed of six hundred miles per second. It is an accepted construct of physics that motion creates frequency and frequency creates sound.

Whether we hear it, *everything* has a sound, a vibration all its own. The velocity (frequency) of the movement determines the specific sound. While we hear the sound of a fan moving the air, we cannot hear the sound of an electron. The speed of an electron is so fast that it creates a tone outside our human range of hearing. Nonetheless, the "sound" is there.

The fact that sound waves* are everywhere is an important point of reference in building conscious sound awareness. And to help you reawaken awareness of sound and the role it can play in your life, add the phenomenon of resonance.

Resonance can be defined as "the frequency at which an object most naturally vibrates." For example, a tuning fork that is tuned to 440 Hz (cycles per second) will, when physically struck, vibrate at 440 Hz. This frequency is known as its *resonant frequency.*

If you have two identical tuning forks manufactured to vibrate at 440 Hz, an interesting example of resonance occurs. Strike one of the forks to produce a sound and the second one, which has not been physically struck, will spontaneously vibrate, or sing along, with the first tuning fork. It acts as if it too were physically struck, and it was, by the sound waves from the first tuning fork. If a fork tuned to 100 Hz is struck nearby, however, the 440 Hz fork will not respond. Thus, when two or more objects have similar vibratory characteristics that allow them to resonate at the same frequency, they form a *resonant system.*

Resonance is a natural ability; substances such as metal, wood, air, and even living flesh and bone vibrate to a frequency imposed from another source. This aspect of resonance is known as *sympathetic vibration.*

SYMPATHETIC VIBRATION

Imagine that I have two violins tuned alike. I place the first violin on a table and leave it there; then I move to the other side of the room. I take the second violin and bow a single open string (say, the D string) ten feet away from the first violin. What happens? The soundbox of the first violin will

*Sound waves can be defined as "oscillations in pressure or longitudinal-wave disturbances in any compressed substance, especially air."

begin to vibrate as the sound frequencies of the second violin resonate the nonplayed instrument's D string. If I play the A string on the second violin, the first violin's A string will correspondingly resonate. If I play all four open strings on the second violin, likewise all four open strings on the first violin will vibrate. As with the tuning forks, this is the resonant phenomenon of sympathetic vibration.

Everything has its resonant frequency—I think of it as a "resident," or home, frequency—and we humans are no exception. That is why certain colors feel good to us and why we are attracted to certain instruments and sounds. The colors or sounds are within our resident frequency range and can make us vibrate from across the room. Our familiarity with their frequency has an effect on our mood.

Some people like the sound of the saxophone; for others, it is like fingernails on a chalkboard. Your teenager loves that electric guitar sound; it drives you to distraction because it grates on your nervous system: different people, different frequency perception. The connotation of sound varies.

The concept of sympathetic vibration—the way an outside vibration can sympathetically vibrate another vibration—holds true with people, too. When you are around someone with a vibrational rate similar to your own, you feel comfortable and familiar. Likewise, you instinctively know when someone's energy field is totally different from yours.

So when it comes to music and sound, finding sources that resonate positively is a good and healthy thing. If you passively allow yourself to be surrounded by sounds that do not resonate well with you, however, you stand a good chance of creating nervous system friction, a loop of internal interference. Continued exposure over a long—or sometimes even a short—period can cause you to simply fall out of tune, out of harmony with your body's inherent wisdom state. Secondhand tobacco smoke has been proved to have deleterious effects. What about secondhand sound? The phenomenon of sympathetic vibration is contingent not on volume but on pitch. This means that even quiet home or office sounds—the hum of a computer, fluorescent lights, a refrigerator, or a television—may be resonating you.

We are constantly being vibrated, on a cellular level, by heard and unheard sound frequencies: electromagnetic fields of all kinds, microwaves, electricity, radar, jet planes, jackhammers, horns, sirens, and loud sounds of many kinds, including music. The increase in stress-related disease in modern society is of little wonder. Many things contribute to stress, which might be defined as "an overamping of the nervous system." A jagged nervous system

is a stressed nervous system. The food we eat, the people we are around, and the thoughts we think have a proven effect on our well-being. It is time to add sound to this list.

If you combine the universality of sound vibration with the idea that we can be affected by external frequency sources, you begin to glimpse the importance of sympathetic vibration.

The goal is to not become paranoid about every sound around you, wondering whether it is vibrating you into schizophrenia or cancer. While we do not have earlids to block incoming sound, the brain has a magnificent adaptive mechanism that allows us to shut down, closing out unwanted sounds; however, we pay a long-term price for doing so. I discuss this in chapter 5 when I look at the work of Dr. Alfred Tomatis and neurodevelopmental specialist Robert Doman, whose contributions to the field I discuss online at TPOS.com and again in parts 2 and 3 of this book.

As you develop a new sound awareness, the basic objective is to become conscious of the principles of sound so you can make informed and intentional choices about the frequency elements with which you surround yourself. In the following lighthearted chapter, I explore the medium of sound from a physics point of view.

CHAPTER 2

The Physics of Sound

The horizons of physics, philosophy, and art have of late been too widely separated, and as a consequence, the language, the methods, and the aims of any one of these studies present a certain amount of difficulty for the student of any other of them.

Hermann Helmholtz

You might imagine that the complaint that heads this chapter resulted from recent trends toward specializing and compartmentalizing knowledge. The complainer, however—Hermann Helmholtz, a brilliant German physicist and philosopher and the author of *On the Sensations of Tone*—was in 1862 bemoaning the seemingly unbridgeable chasm between art and science that still exists today. Perhaps this fragmentation of knowledge explains why Helmholtz spent many years building and studying instruments, compiling all known sound data, applying intricate mathematics and physics formulas to harmony, and investigating the effects of tone on the nervous system.[1]

As a scientist, philosopher, and psychoacoustician (long before the term was first enunciated), Helmholtz researched the human perception of sound. He attempted to bring together two diverging systems to bridge the gaps in human understanding. His work reflects a common desire to reunify mind and body, heart and soul, and most specifically, art and science.

In my undergraduate studies, I came across a wonderful text titled *Conceptual Physics*. In its author, Paul G. Hewitt, I found a lover of science

who also possessed a sense of poetry and humor. Hewitt's discussion of sound includes this delightful passage:

> *Many things in nature wiggle and jiggle.*
> *We call a wiggle in time a vibration.*
> *A vibration cannot exist in an instant,*
> *but needs time to move to and fro.*
> *We call a wiggle in space and time a wave.*
> *A wave cannot exist in one place,*
> *but must extend from one place to another.*[2]

Hewitt has skillfully refined the physics of sound into four concepts. Let's take a closer look at what this poem says about the building blocks of sound.

"MANY THINGS IN NATURE WIGGLE AND JIGGLE."

Frequency is one of the most important elements in any discussion of energy, be it molecular, light, or sound. The term *frequency* refers to how often any regularly repeated event occurs in an assumed unit of time. Therefore, we can refer to the frequency of atomic vibration, of planets around the sun, or even of a heartbeat. For each of these events, a scale of measurement has been devised. In sound and light, we refer to the frequency of vibrations. This unit of frequency is measured in hertz (Hz), the number of vibrations or cycles per second (cps).

"WE CALL A WIGGLE IN TIME A VIBRATION."

Vibration is defined as a "rapid alternating motion to and fro, or up and down." This vibrational motion can be produced in any medium made up of molecules—earth, water, air, metal—if there is a disturbance of that medium's equilibrium. If the vibration occurs among particles—sound will be produced.

What causes the disturbance of equilibrium? The answer is any vibrating source. This could be a saw cutting wood, a hammer striking a nail, the strings of a guitar, the reed of a wind instrument, or the fluctuation of vocal cords.

"A VIBRATION CANNOT EXIST IN AN INSTANT,
BUT NEEDS TIME TO MOVE TO AND FRO.
WE CALL A WIGGLE IN SPACE AND TIME A WAVE."

Using physics as our guide, we note that *waves* are defined as "rhythmic alternations of disturbance and recovery in successively contiguous portions of a fluid or solid mass." This is true, but what does it mean? Essentially, a vibration needs something to carry it along. The wave is the vehicle, so to speak, on which the frequency of vibration travels. But an important distinction needs to be made here. The image of a vehicle conjures up, say, a bus, picking up a bunch of vibrations and delivering them somewhere. At the same time, I have always thought that a sound wave was like a ribbon of energy that, in its entirety, started one place and went somewhere else. Both images are common misconceptions. A wave does indeed carry energy outward from the source. But instead of this energy getting on a single bus and later getting off, it is actually transported by millions of buses—molecules.

Let's use this image instead: you are stuck in miles of bumper-to-bumper traffic, and you are hot, cranky, and holding a big secret, which happens to be nothing less than *the original impulse of sound!* Now imagine getting out of your car and, after exchanging a few pleasantries, getting into the car in front of you and telling that driver your secret. He says, "Good grief! Does anyone else know?" and gets out of his car and into the car in front of his, telling the next driver your original secret. This driver then gets out of her car and goes to the next, and the routine goes on and on and on. In the meantime, you are still sitting in the first car while the secret has been passed along by others.

Fortunately, waves don't have to open and close car doors. And instead of having to ride in zillions of cars, the original vibration hitchhikes on molecules. This is basically how energy travels: the original sound impulse moves while the molecules stay put. Molecules, like bumper-to-bumper cars, remain in the same place after the impulse has passed through.

Almost all information comes to us in the form of some kind of wave, of which there are many: the waves on the surface of water, the waves of the air that convey sound, and the waves of ether that are concerned with the transmission of light, heat, and electricity.

"A WAVE CANNOT EXIST IN ONE PLACE, BUT MUST EXTEND FROM ONE PLACE TO ANOTHER."

Wave motion is the phenomenon of a transfer of energy (or information) from one source to another. The vibration is the information. The wave is the impulse that carries the information outward. The wave motion is the propulsion of that information out into the world. This propelling of the wave is accomplished through what is called *compression and rarefaction,* a process involving the alternating density of molecules in the air and how information is passed.[3] It is through compression and rarefaction that the actual energy of sound is transmitted.

The study of physics tells us that what is transported from one place to another is a disturbance in a medium but not the medium itself. The medium carrying the wave returns to its initial condition after the disturbance has passed.

When air blows over a field of tall grass, we see the movement of each blade as it bends and then returns to its original state. Likewise, as waves move through water, a rubber duck will bob and dip in response to each one that passes, but after it has passed, both duck and the particular batch of water it sits in will be in roughly the same place. The same holds true for the molecules in the air, but because air is invisible, we don't see this springy, to-and-fro movement. In the movement of sound waves through the air, it is not the air that travels, rather, it is the impulse, the wave, using the air as the medium in which to travel (think of hitchhiking molecules).[4]

THE COMPONENTS OF SOUND

Let's put together the components of sound:

- *Sound* is a sensation caused by an object or objects that vibrate.
- When we put out a sound, a *vibration* at a certain rate (*frequency*) is created.
- This vibration then becomes a sound *wave* if it is in a medium that allows it to travel (that is, a medium in which the molecules are not too dense, as they are in rubber or putty, or where there are no molecules at all, as in a vacuum).
- This information is then transported by molecules (*wave motion*).

The molecules themselves are not traveling with this information; they are essentially handing it from one to another. They are serving as transfer points for information, and the way they do this is by taking on the vibration of the initial pulse and handing it over to their neighbor as they spring back into place to receive the next impulse (compression and rarefaction). It is essentially a game of molecular baton passing.

SOME FURTHER PROPERTIES OF SOUND

Knowing some of sound's special properties will enlarge your comprehension of the nature of sound.

As I previously stated, a *sound* can be defined as "a sensation caused by an object or objects that vibrate." A *noise* is any unwanted sound; the term is obviously very subjective. *Pitch* signifies how high or low a tone sounds to the ear; this is also a subjective impression. We say a piccolo sounds high and a tuba sounds low. In fact, the piccolo is vibrating at a high frequency and the tuba at a lower and slower frequency. Pitch is any periodic frequency between 20 and 20,000 Hz. The lowest note on a full-sized piano is A0, with a frequency of 27.5 Hz, which means this tone is vibrating 27.5 times per second. The highest note on this piano is C8, with a frequency of 4,186 Hz; this tone is vibrating 4,186 times per second! *Tone* can be defined as "a sound of definite pitch and duration."

We hear the pitch of a tone only if it possesses *periodicity,* which means that the vibration repeats precisely the same pattern on a regular basis.* Only if something repeats at the same frequency will it produce a steady tone. With the exception of percussion, music is made up of tones. For example, orchestras tune to the pitch of A = 440—an A tone vibrating at 440 cycles per second. However, another example of a tone is the sound of a jet engine. It may not seem musical, but it does have a pitch because it is vibrating with regular periodicity.

If a sound is *nonperiodic,* which means that it has no regular pulse and frequency, it will not produce a tone. Rather, we will perceive the sound either as percussive or as noise. In terms of percussiveness, nonperiodic sounds can be rhythmic in nature and are most often of short duration. In terms of noise, the sound of traffic and the crunching of a newspaper are nonperiodic sounds; they have changing frequencies and irregular patterns.

*A pattern is "an arrangement of form, a definite direction, tendency, or characteristic."

Concepts, as we know, are not fixed in stone. To say that periodicity or nonperiodicity determines the difference between tone (music) and noise would be misleading, albeit often true. A musical note is periodic, whereas a handclap is nonperiodic. Yet if the handclapping is performed in a repetitive, periodic fashion, while not tonal, it is musical. A jackhammer is very likely periodic and very definitely noisy. And a conga drum solo is nonperiodic and quite musical. Helmholtz attempted to bridge the difference between periodic and nonperiodic vibration when he said, "The sensation of a musical tone is due to a rapid periodic motion of the sonorous body; the sensation of a noise to non-periodic motions."[5] As you have seen, in most cases this is true.

Continuing, a *sonorous body* is anything capable of producing sound, especially of deep and rich quality. All musical instruments—the body of a cello and the soundboard of a piano—are sonorous, as are the rib cage of a soprano and an apple juice jug. These sonorous bodies are the containers of the vibration; it is the molecules inside the wood of a violin that are set into vibration by the bowing of the string; in turn, the air inside the soundbox amplifies the vibration.

As I noted, the parameters of the normal human *hearing range* are between 20 and 20,000 Hz. Some creatures, however, can hear outside this range. Dogs hear above 20,000 Hz, as do dolphins, elephants, and alligators, among others. Because of normal physiological processes, as we age, the highs and lows that we hear begin to diminish.

Sound waves above 20,000 Hz are called *ultrasonic. Infrasonic* waves are those below 20 Hz, which are perceived as rhythm, if they can be heard at all.

Timbre is the tone color or characteristic quality that distinguishes one voice or musical instrument from another, determined by the harmonics of the sound.

Like pitch and timbre, *loudness (amplitude)* is actually a psychological impression. Loudness is a perception of sound strength; what may be offensive to one person is comfortable to another. Loudness is also a function of intensity. Vigorous vibrations produce more intense sound waves, which cause larger air pressure variations, which then have an impact on the eardrum.[6] *Volume* can be defined as "the quantity, strength, or loudness of sound." In the world of sound, *volume* is synonymous with *loudness* or *amplitude.*

Loudness is measured in *decibels* (dB). A falling pin measures 10 dB, a whisper 30 dB, a quiet conversation 40 dB, a subway train 90 dB, amplified rock music 110 dB, a jet engine at ten feet 130 dB. For most people, pain begins at 110 to 120 dB. Levels above 100 dB not only are unpleasantly

loud but also can cause ear damage, which gets progressively worse with prolonged exposure. Ear damage can actually begin with lengthy exposure to noise levels above 85 dB.

Sound must have a medium in order to vibrate. If there is nothing to compress and expand, there can be no sound. Any elastic substance can transmit sound, be it liquid, gas, solid, or even plasma. Hewitt says that "compared to solids and liquids, air is a relatively poor conductor of sound," yet it is our primary medium for receiving sound. Hewitt goes on to describe how the sound of an approaching train can be heard sooner if you put an ear to the rail. This is because the vibrations are moving fifteen times faster through the metal than through the air. In water, sound travels about four times as fast as in air.[7] Much like listening to sound through a metal rail, indigenous warriors or hunters often put an ear to the ground to hear sounds that were not yet audible in the air.

The transmission of vibrations from a vibrating body to another body is, again, called resonance. This phenomenon takes place only when the two bodies are capable of vibrating at the same frequency.

It is from resonance that sympathetic vibrations come. A bowed note on one violin's open string will make the same string vibrate on another unplayed violin if it is in the vicinity. The second instrument is playing sympathetically. A violin, however, could not make a rock sing; their two bodies are too different. Resonance takes place frequently with pianos and tuning forks. In this book you will also learn about the direct application of resonance to people.

A NOTE ON LIGHT AND SOUND

A common misunderstanding regarding the relationship of light and sound is the notion that because both are by-products of frequency, it is just speed and perception that separate them. This being the case, it would seem reasonable to say that sound is actually slow light and, conversely, that light is fast sound. Taking this concept of a single large spectrum of vibration even further, you could say that all the sensory receivers located in our heads—eyes, ears, nose, and mouth—are there to perceive the frequencies of light, sound, smell, and taste, each being calibrated to a different segment of the same frequency spectrum.

It's a great concept, but it's not true.[8]

This is how light and sound are similar:

1. They both move through space very rapidly as waves.
2. They are both perceived by sense organs in our heads.
3. They both have the same source—vibrations.
4. They both are measured in Hz.
5. Physicists and other beings love them both.

This is how they are different:

1. *Speed.* Light moves at the unbelievable rate of 186,000 miles per second! Sound looks like a laggard at only 1,100 feet per second. Therefore, in five seconds sound has traveled only one mile, while light has traveled 930,000 miles (equivalent to thirty-seven times around the globe). This is why you see the lightning long before you hear the thunder, even though they happen simultaneously.
2. *Waves.* Light moves on a transverse wave (crossing side to side) in direct lines; sound moves spherically on longitudinal waves.
3. *Material.* Light depends on an electrical exchange of energy. It is not dependent on any physical matter. It does not need molecules to push around; it travels through the vacuum of space! Sound, however, depends on the molecules of physical matter being displaced. For its waveform to exist, sound requires solids, gas, liquids, and so on, or else it won't play.
4. *Constancy.* The speed of light rarely changes. The speed of sound absolutely changes based on the environment.
5. *Consistency.* Light is an electromagnetic force. From the slowest frequencies to the fastest, its frequencies are: radio wave, microwave, infrared, and ultraviolet. Sound is a grosser phenomenon involving physical matter.

While our human bodies are made up of the same basic components as light and sound—light is electromagnetic and sound is physical matter (atoms and molecules)—it seems that we are tuned to handle the vibrations of sound more easily than those of light. Perhaps we can vibrate with sound because each of us can produce and hear sound, whereas making discernible light—from our minds and bodies—is a fairly advanced art form.

We can also make sound from our bodies; it is a part of us! With sound, we have a tool to merge with the greater sonic stream and be resonated by it. Sound may be an interconnection to realms previously inaccessible without our conscious awareness. Sound is available for us to play with, manipulate, mold, swim in, and ride on. At 770 miles per hour, sound is within our conceptual and practical reach.

CHAPTER 3

The Mechanics of Hearing

It is often said that the primal instinct of all animals is twofold: survival and reproduction. Human beings are no exception. Our sensory organs are barometers of conditions outside the body. Is it safe? Do we need to run away? Can we relax? Can we sleep? The eyes, ears, nose, mouth, and skin are essentially body scouts, constantly surveying the outer scene and sending reconnaissance reports to central headquarters.

Our eyes—the sensory organs to which most attention is paid—perform one function brilliantly: the detection of the presence of light and image. The ears, mostly relegated to a secondary role, serve multiple purposes: they convert sound into electrical energy that charges the brain, they keep our physical equilibrium, and they analyze acoustic information, thereby allowing us to communicate.

The focus of this chapter is on what takes place once sound waves enter the outer ear. I examine the steps that occur as the incoming air fluctuations of sound convert into electrochemical impulses that are processed by the brain. The understanding of how we hear brings a deeper awareness of the impact of sound, and with this understanding, we can assess the value of the sounds around us. As our eyes see what is in front of us, so our ears hear what is around us. And just as we can sometimes choose what we wish to see, we can also exert our power of choice on what kinds of sounds we are willing to let bathe our psyche.

The emerging field of soundwork or sound therapy, which is different

from music therapy, is based on the theory of vibration: how frequency resonates and affects our nervous system. Soundwork is neurological in nature, working with vibrations to create a charge in the brain and nervous system.

Through the understanding of what happens to sound once it enters our heads, we can more easily ascertain which sounds actually strengthen us, as well as which frequencies weaken us. The power of sound is often subtle and therefore easily ignored. But it is through this subtlety that sound surreptitiously influences our energy, our health, and our entire ability to stay in balance. As with so many kinds of sensory input—food, aroma, sound, image—we have a choice as to how and what we ingest.

THE JOURNEY OF SOUND

From the study of physics, we know that audible sound creation and transmission consists of four basic stages:

- Something vibrates.
- This disturbance creates a wave, spreading out to all molecules around it.
- The pulse of the wave rapidly passes from molecule to molecule.
- The pulsing molecules nearest the ear vibrate the eardrum.

But what happens then?

The Ear

The ear itself is a funny slab of skin extending from the side of our head like a primordial radar dish. And much like its technological emulators, the ears simply hang out, dutifully awaiting information. In the world of physiology, function defines form. And the function here is to scoop up sound and transfer it inward.

In order to accomplish this "recycling" of sound, the mechanism of the ear is highly sophisticated. Its circuitry is miniature and delicate, hidden from view, and protected inside the recesses of the temporal bones of the skull. Conventional wisdom has long believed that the ear is divided into three parts: the outer, middle, and inner ears.

The outer ear or external ear. This consists of the pinna (auricle), auditory canal (meatus), and eardrum (tympanic membrane). The *pinna* is the corrugated flap of skin on either side of the head. Its broad function is to

corral sound waves and funnel them through the external auditory canal toward the eardrum. The *auditory canal,* about one-inch long in adults, allows the delicate eardrum to be set inside the skull, where it is safely protected. The *eardrum* is a thin disc of fibrous tissue. It vibrates with the sound waves; the alternations of air pressure cause it to bulge inward and outward.

The middle ear. This is the small, connecting section of the sound highway. A hollow region directly behind the eardrum, the middle ear is only about two milliliters in volume. Here are located the *hammer* (malleus), *anvil* (incus), and *stirrup* (stapes) we all remember from physiology class. The middle ear houses these three small bones, collectively known as *ossicles.* Conventional wisdom asserts that the job of the ossicles is to transfer sound vibration from the eardrum (outer ear) to the cochlea (inner ear). Working together, these bones form a lever system. The handle of the hammer sits against the inside of the eardrum. The anvil rests between the hammer and the stirrup. The foot of the stirrup presses against the *oval window,* which is the opening in the bony process surrounding the cochlea. As the eardrum fluctuates, the ossicles are the bridge on which the mechanical vibrations cross over.[1]

Dr. Alfred Tomatis proposed an alternative concept about the pathway of sound and the role of the ossicles. He believed that sound is *not* transferred through the ossicles, as is the common belief—referred to as the Helmholtz-Békésy concept. Tomatis stated, "The peripheral bone that surrounds the tympanic membrane, especially in the lower area, conducts the sound toward the inner ear." Essentially, it is the entire bony structure of the middle-ear chamber—not the ossicles—that transfers sound vibrations to the inner ear; the primary function of the ossicles is to serve as a protective muting device to protect the inner ear from dangerously loud sounds. (For more about Tomatis, see chapter 5.)

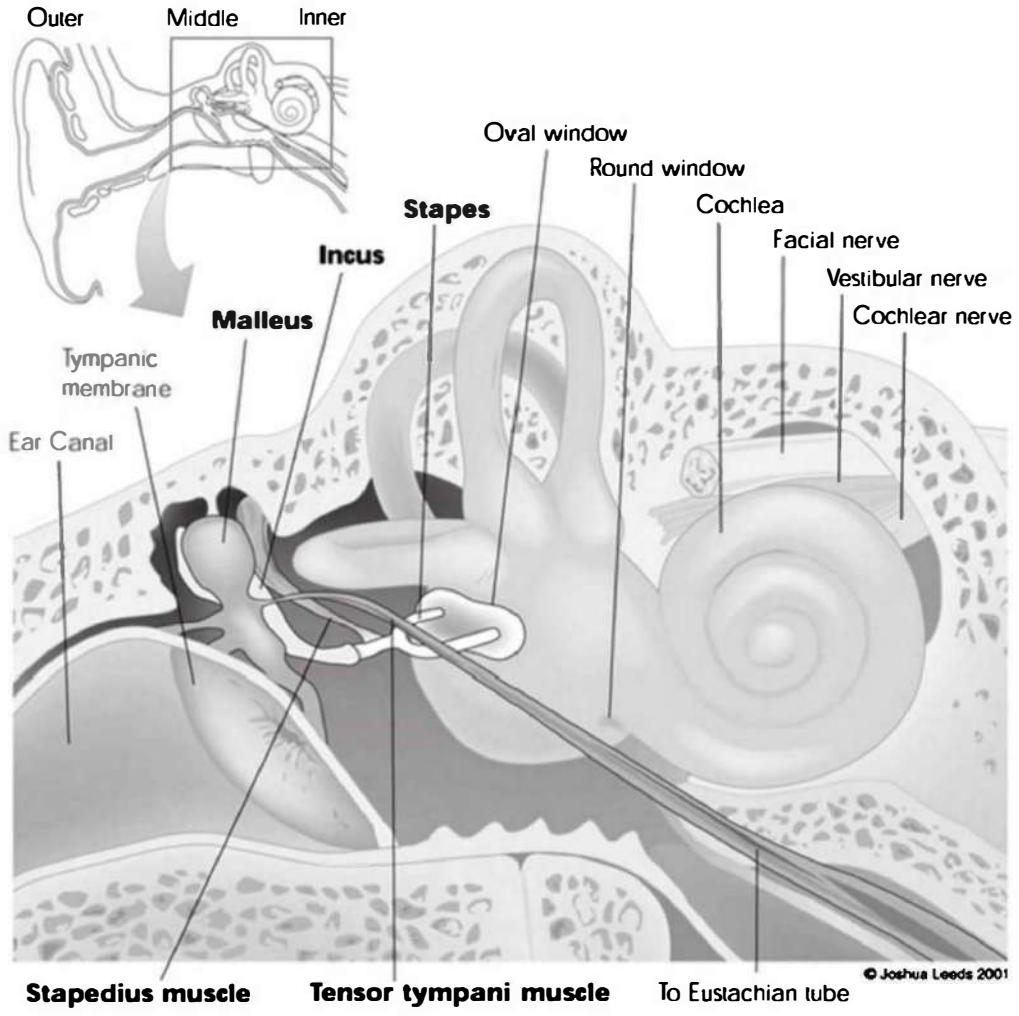
The middle ear also contains two small muscles that are quite often ignored (a current physiology text does not even bother to mention them). The *tensor tympani* is attached to the hammer and increases the tension in the eardrum. The *stapedius* pulls the stirrup sideways. The effect of this counterlevering is to reduce the mobility of the ossicle chain, thereby reducing the sound transmission through this middle chamber. This protects the inner ear from damage from very loud sounds.

The role of these two tiny muscles, however, goes much further than this. In fact, they are of major importance in the groundbreaking auditory retraining work of Tomatis and his Electronic Ear. According to Tomatis,

the tiny stapedius muscle is the only muscle in the human body that never rests. It constantly regulates our perception of sound from the sixteenth week in utero until the moment of death.*[2]

The inner ear or cochlea. Like an alchemist's laboratory, this sacred sanctum of hearing is where transformation takes place, for it is here that the vibration of sound is converted into electrical signals. It is also in the inner ear that the vestibular system resides. The *semicircular canals* and the *vestibular sacs* are the upper part of what is known as the *bony labyrinth of the inner ear.*

The cochlea is the bottom part of this labyrinth. The function of the vestibular system includes balance, maintenance of the head in an



*In reference to this statement, questions have been posed regarding the heart. Wouldn't it fit into the same category as the stapedius—as a muscle that never stops? According to Dr. Bradford Weeks, "The heart pulsates, a motion which involves periodicity and therefore a rest of sorts." Still the point of great interest is that a muscle in the middle ear never stops. According to Weeks, "This consistency has significance as regards critical charge." Whether it is the only muscle to make the claim of perpetual motion is actually immaterial. What is of note is that sound information is being processed nonstop without even the gap of a normal muscle's rest cycle.

upright position, and adjustment of eye movement to compensate for head movements.

The cochlea houses the intricate mechanisms for this alchemical transaction and will be the focus of my inner-ear exploration. The word *cochlea* derives from the Greek word *kokhlos,* meaning "land snail." Indeed, the shape of the cochlea is similar to the shell of a snail; it is a gradually tapering cylinder of two and three-quarter turns. Unrolled, it would be about an inch and a quarter long.

For the purposes of visualization, imagine the cochlea unfurled. The cochlear shell is divided longitudinally into three sections: The *scala vestibuli* and the *scala timpani* are chamberlike areas, filled with a fluid called *perilymph.* These regions are divided by a very complex structure called the *cochlear duct (scala media).* The cochlear duct is hollow and filled with another fluid, *endolymph.* It is in and adjacent to this cochlear duct, which is actually the middle and smallest chamber of the three, that the major transformational activities of converting wave motion to electrical impulses take place. Herein lies a section of the inner ear called the *organ of Corti,* consisting of three elements: the *basilar membrane, hair cells,* and the *tectorial membrane.*

Let's retrace the path of sound incorporating the information above.

Sound waves are funneled via the outer ear through the auditory canal to vibrate up against the outside of the eardrum, which is like a taut drumhead. Pressing against the inside of the eardrum are the three tiny bones (hammer, anvil, and stirrup) known as ossicles. Their job is to transfer the vibration from the eardrum to the cochlea, intensifying the energy transmission.

Vibrations enter the cochlea through an opening of the bony structure called the oval window. These vibrations set the perilymph, one of the internal cochlear fluids, into motion. Interestingly enough, the sound waves in the air have now become liquid waves inside our heads. The low frequencies cause the wave motion to move all the way up and around the cochlea and come back down the other side. Higher frequencies take a different route. Because they create much faster waves, there is not enough time for them to traverse the upper and lower chambers without causing excessive compression. Therefore, high-frequency waves essentially recirculate by going a very small distance up one side of the top chamber, then flexing the basilar membrane, which lies between the upper and lower chambers. This in turn creates wave motion in the lower chamber. So, having traveled this far, what happens in

the movement of fluid that now transforms sound into electrical energy?

In the middle chamber of the cochlea is the alchemist's workbench, the organ of Corti, made up of the basilar membrane, 15,400 hair cells, and the tectorial membrane. The basilar membrane rests just between the lower and middle chambers. Anchored on this membrane are hair cells, with fine, hairlike appendages at the top of the cell similar to eyelashes; these are known as *cilia*. The cilia are stiff and rigid, arranged in rows according to height. Anchored to the basilar membrane, many of the hair cells also attach to a parallel membrane known as the tectorial membrane.

The motion of the sound waves causes the basilar membrane to move relative to the tectorial membrane. This bends the hair cells' cilia, and this back-and-forth bending of hairlike auditory receptors initiates signals on the individual fibers of the *auditory nerve*. In other words, the cilia are like a trip switch: once they are set in motion, chemical actions are induced, sending electrochemical activity through neurons, the nerve cells of the brain. Before we know it, sound is on its way to numerous auditory centers in the brain.

Let's trace these new stages:

- Vibration hits the eardrum; it is passed along by the ossicles and introduced into the cochlea, where it becomes sound waves.
- Waves, circulating around the cochlea, move the basilar membrane and cause the cilia to bend.
- This movement of cilia stimulates neuronal activity, beginning an electrochemical journey into the brain through the eighth cranial nerve. Ultimately, it is both the vibration of the basilar membrane and the actions of the brain that determine our perceptions of sound.

THE AUDITORY PATHWAY

The bending of the cilia at the tip of a hair cell causes a series of reactions inside the cell. Chemically stated: ion channels open and close, potassium flows in and out, and neurotransmitter substances increase and decrease.[3] You can see the ebb and flow of reactions tied to the movement of the sound waves inside the cochlea. Imagine the speed at which this all transpires; each of these reactions occurs multiple times for every slight segment of sound we ingest. The inner ear, not unlike other parts of the body, is a high-speed processor of information. It essentially digests megabytes of sound before sending sonic nutrients to the brain. Recall that *the primary function of the ear is*

*to charge the neocortex of the brain with electrical impulses.** Most sounds will accomplish this—some more effectively than others.

You can see the pivotal role that auditory hair cells play in the transmutation of sonic information. But beware! The sensation of loudness is a factor of how many cilia are brought to excitation; these cells can be permanently damaged when the ear is exposed to extremely loud sounds. If you were a fish, bird, or amphibian, broken hair cells would regenerate. Unfortunately, humans cannot repair these damaged cells.

The anatomy of the auditory pathway—and what takes place once the stimulus arrives in the auditory cortex of the brain—is even more complex than that of the visual system. Consider the following:

The neuron is the information-processing and -transmitting element of the nervous system. Each neuron receives information through its branchlike dendrites and transmits it to other neurons through synaptic connections. The average neuron links up with sixty thousand other neurons—with a capacity of two hundred thousand connections or more! There are more than ten billion neurons in the brain.

None of the auditory neurons goes directly to its final destination in the *primary auditory cortex*. Instead, auditory signals mix and get processed at several stations along the way. They visit numerous places in the *medulla* (lower brain) and then make stops in the *midbrain* and *cerebrum* before arriving at the auditory cortex. This area is located on both sides of the brain, tucked away inside the *sylvian fissure*. Signals come from both ears, traveling separate pathways. Each hemisphere of the neocortex receives information from both ears, but its primary source is the opposite ear (that is, the auditory cortex in the left hemisphere receives most of its information from the right ear). It should be noted that the maze of the brain is so complex that the above-stated routing of auditory signals should be considered only a simplistic generalization.

The transference of electrochemical signals pertains to the sound coming from the auditory nerve—out of the cochlea—and up into the medulla,

*Much of the theory of this book is based on the discoveries of Dr. Alfred Tomatis. Dorinne S. Davis—an audiologist, sound therapist, and the director of the Davis Center for Hearing, Speech, and Learning in Budd Lake, New Jersey—makes an observation about the statement that "the primary function of the ear is to charge the neocortex of the brain with electrical impulses." She points out that to those who study the science of *hearing* (as distinguished from *listening*), the primary function of the ear is to register sound. The Tomatis circle of influence is small within the general audiology community at this time.

located in the brain stem. But the fact is that sound is actually collected and disseminated throughout the body by numerous nerves and by bone conduction.

THE EAR AND THE BODY

Because most cranial nerves lead there, the ear has been called "the Rome of the body." According to Dr. Bradford Weeks, ten of the twelve cranial nerves are affected by the ear. Most of the cranial nerves regulate the motor functions of the head and neck area, including all the sensory organs located in the head. Weeks adds that all motor functions in the head—except smell, the tongue, and the neck muscles—are affected by the ear. This includes vision, eye movements, facial sensations, chewing, taste, and head and neck muscles.[4]

One of the most fascinating facts about hearing is the relationship of the ear to the *pneumogastric,* or tenth, cranial nerve. This nerve is also called the *vagus* (wandering or vagabond) *nerve* because it meanders through the thoracic and abdominal cavities. The enormous task of the vagus nerve is the functional regulation of a host of organs, from the larynx, heart, lungs, stomach, liver, bladder, kidneys, small intestines, and colon all the way down to the anus. And the vagus nerve attaches to the outer and inner eardrum on its way south from the brain. What is the significance of this interconnection? An important conclusion asserts itself: vagus nerve communiqués to the rest of the body are affected by the ear! This vagus nerve–acoustic interaction means that mixed into the parasympathetic instructions to our major organs are vibrations from the eardrum. And what makes the eardrum vibrate? Sound. And who determines the sounds we put into our ears? Or, getting specific, who determines the vibrations we put into our internal organs? Clearly, the effect of sound can no longer be simply measured by how our ears feel. The ear brings in energy that touches us from top to bottom. Sound is not just vibrating the eardrum. It is actually resonating the entire being.

Having discussed the nature of sound, the physics of sound, and the mechanics of hearing, let's turn our attention to the fascinating world of resonance—the impact of one vibration on another. Given that sound is a vibration and that we have an extraordinary system designed to perceive and translate sound vibrations, the question arises, *What effect does resonance have on you?*

CHAPTER 4

Resonance, Entrainment, and Pattern Identification

After analyzing, researching, and producing benefit-specific music for twenty-five years, I've come to the conclusion that three primary processes contribute to the effect of music and sound on the nervous system: resonance, entrainment, and pattern identification. I refer to this holy trinity as *tone, tempo, and pattern.* Regardless of the proportion of each of these vital ingredients, something is being resonated by a high or low pitch, everything is regrouping around periodic tempos, and the brain is hardwired to find a pattern. How we mix and match tone, tempo and pattern determines the effectiveness.

RESONANCE (TONE)

Resonance can be broadly defined as "the impact of one vibration on another." Literally, it means "to send again, to echo."

I mentioned an example of resonance in chapter 1: The open string of an untouched violin sounds when a similar string on another violin is played across the room. The untouched violin is responding to the similar frequency of the violin that is actually played. The frequency that is causing the string of the untouched violin to sound—the resonant frequency—is the frequency at which the unplayed string most naturally vibrates.

To *resonate* is to "re-sound." Something external sets something else into motion, or *changes* its vibratory rate. This can have many different effects—some subtle and some not so.

The term *sympathetic vibration* refers to the phenomenon of resonance whereby one object's vibration alters that of another object. If you can match the vibratory rates of another object, it will "sympathetically" change. Matching a vibratory rate creates a resonant system. For example, a stationary rock won't cause a nearby table to vibrate sympathetically; their vibratory rates are very different, and they don't share a resonant system. But place a struck tuning fork on a table and the sound will be much louder than the fork would make by itself. This is an example of *forced vibration.* The sound of the tuning fork is louder because the table is forced to vibrate by the vibrations of the tuning fork and, with its larger surface area, sets more air in motion.[1]

The principle of resonance holds true with people as well as tuning forks and violins. When we find ourselves feeling good around somebody, we actually use the phrase *good vibes.* Sharing both metaphorical and real sensitivities, we feel good because someone with a similar frequency "feels" familiar. Familiarity brings a sense of safety and security. These comfortable feelings allow us to be natural and unguarded. Soon we actually resonate with the other person. It is a close feeling, be it on a mental, physical, or emotional level. However, if people resonate in a way that offends or disturbs our resident frequency rate, we move away from them because we do not want to be affected by the vibrations they emit.

The image of an opera singer's voice shattering a crystal glass is commonly used to represent the concept of resonance in acoustics. Here's how it works: the singer taps the glass lightly and hears the sound that it emits. This sound is the glass's natural frequency. By then singing a very pure and steady tone at that same frequency, the singer builds up a strong resonant response, a vibration with amplitude large enough that it may exceed the breaking strength of the glass.[2] Another example of overamping resonant structures: soldiers "break step" when marching across a bridge. There has been at least one instance—on a footbridge in Manchester, England, in 1831—in which soldiers' combined rhythmic marching matched the natural frequency of the bridge structure and caused it to fall apart. Unintentionally, the soldiers created a resonant system.[3]

Resonant systems occur in nature as well. In 1940, the Tacoma Narrows Bridge in Washington State was destroyed by wind-generated resonance.

According to Paul Hewitt, "A mild gale produced a fluctuating force in resonance with the natural frequency of the bridge, steadily increasing the amplitude until the bridge collapsed."[4] Research suggests that giant icebergs are splintered by the resonant force of constant gently lapping waves.[5]

The concept of resonance plays heavily in the construction of airports. Certain materials sympathetically resonate with the sound of the jet engines and, like the bridges, will dissolve. Therefore, materials that will not form a resonant system have to be used. Another aeronautical story of resonance: the ill-fated Electra propjet had a habit of falling apart when rotating propellers matched the natural frequency of the wings.[6]

In medicine, the noninvasive practice of lithotripsy is becoming standard procedure. Pancreatic and kidney stones are being dissolved with acoustic waves. French sound researcher Fabien Maman—director of the Academy of Sound, Color, and Movement—has scientifically documented the effect of sound on cancer cells. Fascinating photographs of microscope slides show healthy cells expanding and contracting at the sound of a nearby xylophone. You see the cells enlarge as they absorb the sound waves, then return to normal size as the sound dissipates. Cancer cells do not have enough flexibility to expand, however, and they explode as the sound waves impact. Healthy cells resonate; unhealthy cells don't.

If concrete and cement can be made to dissolve by sound and rhythm, what about the effect of sound on tissues and organs? The tenth cranial nerve, or vagus nerve, attaches to both sides of the eardrum before traveling down the torso and attaching to every organ but the spleen. Every sound that we hear affects—to whatever degree—the organs of the body through this nerve. To this, add the effect of heard and unheard sound waves against the entire body.

Resonance is the single most important concept to understand if you are to grasp the constructive or destructive role of sound in your life. Entrainment, sympathetic vibration, resonant frequencies, and resonant systems all fall under the rubric of resonance.

NATURAL AND FORCED RESONANCE

Resonating substances can be divided into two types: those that vibrate at their own characteristic frequency, their natural frequency, such as tuning forks and bells,* and those that have the ability to resonate at a variety of

*Factors such as shape and elasticity have a bearing.

frequencies. The first is a free or natural resonance; the second is referred to as *forced resonance* because the sounding frequency forces its tone on the resonating body.[7] Hewitt points out that "most things from planets to atoms and almost everything else in between have a springiness to them and vibrate at one or more natural frequencies."[8] Forced resonance is by far the more important of the two for musical purposes.

In listening to music—or, for that matter, any sound—our eardrum (tympanic membrane) responds to the principle of forced resonance. If our ears worked solely to free resonance, then we would hear only certain frequencies that approximate our own. Many physicists use the example of a child on a swing as an illustration of resonance. The thrust of the pump has to coincide with the natural rhythm of the swing.[9] The trick is in the timing. Pushing or pumping at the wrong time gets the swinger nowhere, but a few well-placed pushes by a parent or friend—at the exact right time—effortlessly propel the child.

While on a recent trip to Germany, I was taken to the Institute for Stress Research in Berlin. In what was once East Berlin, I met with a physicist who used to work with the Russian space program. Now that he was no longer obligated to the Soviet Union, he was applying his expertise to research stress. He spoke excitedly to me about the swing-set example and how similar principles were used in the space program. Knowing the ideal moment to apply propulsion, exert pressure, or create release led to optimal results with minimal exertion. His team of researchers now applies these concepts of resonance to the study of stress, a malady they regard with utmost seriousness and concern. They call their field chronobiology, and the major force they now study is music. These German doctors and physicists believe that with the application of the right music (or musical tones) at precise times of the day—matching the circadian rhythms of the body—they can accomplish tremendous things in the reduction of stress. Like pushing a swing at the exact right moment in the cycle.

Rocket scientists and composers joining forces to create resonant health with quarter notes: the twenty-first century has arrived!

Understanding that all matter vibrates, vibrations have frequency, frequencies produce sounds, and sounds resonate each other propels me into a sonic activism. The more I know about sound, the more I aggressively advocate intentional soundscapes.

ENTRAINMENT (TEMPO)

Another fascinating and important aspect of resonance can be discovered through studying the process of entrainment. *Entrainment,* in the context of psychoacoustics, concerns changing the rate of brain waves, breaths, or heartbeats from one speed to another. The very sound of the word, *en-train-ment,* implies transportation—to embark on a train. The "train" in this instance is rhythm. Our major body pulses can voluntarily ride periodic rhythms to Fasterville or Slowertown.

The most common example of entrainment is experienced when tapping your feet to the external rhythm of music. Just try keeping your foot or your head still when you are around fun, uptempo rhythms. You will see that your desire to keep time through physical movement is almost an involuntary motor response. The natural interconnection between the body's motor skills and external rhythms is one of the most highly researched phenomena in the field of rhythmic entrainment. Rhythm is successfully used as a complementary therapeutic technique for stroke patients, as well as for those patients who have been diagnosed with brain injuries, Alzheimer's disease, autism, and more. It has been ventured that one of the reasons for our easy auditory–motor arousal connections may have to do with adaptive evolutionary processes related to survival and fight-or-flight reactions. Michael Thaut, the scientific director of the Center for Biomedical Research in Music and colleagues say, "It is well known that the auditory system is an extremely fast processor of sensory information." This is because it must capture and extract meaning from sensory information that comes and goes very quickly. Unless you have a tape recorder at hand, what you hear is gone as soon as the sound waves dissipate. Visually, you can stare at a mountain; you can't freeze-frame a sound. Because of this, continue Thaut and colleagues, "an interesting dynamic parallel between the temporal nature of auditory information and movement performance arises." This is confirmed in the speed of our reaction to sound. Write Thaut et al., "Auditory cues create consistently 20–50 milliseconds faster physical reactions than do visual or tactile cues."[10] We respond faster to sound than to sight or touch.

On a lighter level, tapping your feet or bopping your head to external rhythms is just the tip of the iceberg. While your feet might be jitterbugging, your nervous system may be getting a terrible case of the jitters! Rhythmic entrainment is contagious: if the brain doesn't resonate with a rhythm, neither will the breath or heart rate. In this context, rhythm takes on new

meanings. Not only is it entertaining, but rhythmic entrainment is a potent sonic tool as well, be it for motor function or other autonomic processes such as brain waves, heart rates, and breath rates.

The effects of rhythm on the body can be observed in two ways. On an *internal-to-internal* basis, our pulse systems naturally synchronize with each other. The heart rate entrains, or locks in, with the breath rate. If the heart speeds up, it naturally causes the breath to do the same. On an *external-to-internal* basis, our brain waves can be entrained to musical rhythms or the pace of a minister's sermon. In the context of external-to-internal entrainment, sound is the vehicle through which change takes place. Alter one pulse (such as brain waves) with music, and the other major pulses (heart and breath) will dutifully follow.

The focus of this book is the intentional application of music and sound to enhance our daily lives. Therefore, my explorations of entrainment will center on the external-to-internal process in which we use external rhythms to influence the interior landscape.

A generalized scientific definition of *entrainment* is "the effect of one system on another." While the process of entrainment is referred to often in medicine, biology, and other "hard" science disciplines, very little research has been done on the perception of external rhythm by the autonomic nervous system. Psychologists and physiologists rarely consider this, despite the fact that physicists have long known that any atomic matter can be affected by external pulses.

When it comes to the intentional applications of music, the entrainment effect completes the circle of the chain of vibration: atomic matter, vibration, frequency, sound, sympathetic vibration (resonance), and entrainment. *Music alters the performance of the nervous system primarily because of entrainment.*

ENTRAINMENT: RESONATING WITH A RHYTHMIC TWIST

Understanding the interlocking concepts of resonance and entrainment enables us to grasp the way external tone and rhythm can heal or create havoc. Sound affects glass and concrete as well as brain waves, motor response, and organic cells. As I discussed earlier, a structure's resonance may be thought of as that frequency of vibration most natural to it and most easily sustained by it.

Entrainment is part of resonance—but with a twist. There is a subtle but

important distinction here. Entrainment is the rhythmic manifestation of resonance. With entrainment, a stronger external pulse does not just activate another pulse but *actually causes the latter to move out of its own resonant frequency to match it.* Entrainment is a classic example of the principle of forced resonance. When you play music at 140 beats per minute and your heart rate increases over time, you are actively changing your frequency.

According to sound researcher Jonathan Goldman, "Resonance is a cooperative phenomenon between two different objects sharing the same frequency." Stimulate the natural vibrations of an object with its own frequency, and resonance is set in motion. However, Goldman sees entrainment as the imposition of another frequency onto the weaker vibration. With entrainment, he says, "you are actively changing the vibrations of one object to another rate." Goldman thinks of resonance as passive in nature, while entrainment is active.[11]

The concept of entrainment was first noted in 1665 by Christian Huygens, a Dutch scientist. Huygens noticed that two pendulum clocks, mounted side by side on a wall, would swing together in precise rhythm. They would hold their mutual beat, in fact, far beyond their capacity to be matched in mechanical accuracy. It was as if they *wanted* to keep the same time. Huygens assumed a sort of sympathy between the two of them and conducted experiments to learn just how the interaction took place—whether they were linked through the air or through the wall on which they hung. From his investigations (the pendulums, he found, were synchronized by a slight impulse through the wall) came the first explanation of what scientists were to call "mutual phase-locking of two oscillators" or simply "entrainment."[12]

The scientific explanation for entrainment is that any two vibrating bodies will try to synchronize with each other. Why is that? One theory is that entrainment is nature's form of energy ecology. Scientist Itzhak Bentov, a proponent of this view, says that asteroids and planets are actually rhythm-entrained to the gravitational fields of the sun and other planets. Bentov explains that asteroids, which are minor planets, actually develop resonances in their orbits as a reaction to the combined gravitational pull of nearby planets and the sun; they "must dance to the tune of two masters."[13] He continues, "It seems that nature finds it more economical in terms of energy to have periodic events that are close enough in frequency to occur in phase or in step with each other. This is the meaning of rhythm entrainment."[14]

External periodic rhythms—*periodic* defined as "regular" or "ongoing"—

cause our major body pulses to change. In the case of two tuning forks tuned to different pitches, one fork cannot entrain the other; the density of the metal will not allow it. But the more mutable rhythms of nature are very entrainable. This includes human rhythms. We pulse, vibrate, and resonate; these are perfect materials for entrainment. Resonant entrainment of oscillating systems is a well-understood principle within the physical sciences. And because human bodies are oscillators—moving in a periodic, repetitive fashion between two points of rest—the laws of entrainment apply.

F. Holmes Atwater, a scientific investigator, behavioral engineer, and consultant with the Monroe Institute, posits three basic rules of the physics of entrainment:

1. *The resonance rule.* For one system to entrain another, the second system must be capable of achieving the same vibratory rate. In other words, a human being could not entrain with a rock, but he or she would entrain with another person.
2. *The power rule.* For one system to entrain with another, the first must have sufficient power to overcome the second. Therefore, proximity is an important consideration. If the systems are far away from each other, the power is diminished with distance.
3. *The consistency rule.* For one system to be capable of entraining another, the first must be at a constant frequency or amplitude. This is where periodicity comes into play: rhythms must be constant and regular.[15]

RHYTHM, THE PULSE OF LIFE

Rhythm, or periodic movement, is an integral part of life. It determines if sound is a beat or a tone; it provides the contours of speech and melody. In the case of energy, sound, and light frequencies, the rhythm of the waveform distinguishes each frequency.

Rhythm means many different things. To a musician, it is a tool to mark time. To a doctor, the periodic pulse of the heart or brain determines the health of the patient. To an astronomer, planetary gravity fields are critical in the planets' interrelationships. And to the mother and unborn child, rhythms of breath and blood flow provide the womb sounds with which they bond and the baby forms.

Without rhythm there would be no life. While this is a broad and simple

statement, its truth is absolute. Nature could not exist without its interdependent as well as independent rhythms: the dance of day and night, summer and winter, outward blossoms and inward renourishment—graceful acts of balance, all. Too much rain, and we flood. Too much sun, and we bake. Can you imagine the ebb and flow of the ocean wave if the rhythm of balance went awry?

The independence and interdependence of the multiple rhythms of the human body are vital: molecular rhythms, action potentials, cardiovascular and respiratory patterns, even the monthly cycles of menstruation. These are examples of the internal periodicity carried on against the external rhythmic clocks and calendars of seconds, years, and millennia.

From the orbit of stars down to that of an electron in an atom, *periodic rhythm*, the activity of something occurring in cycles, is considered a stable and good thing. It is common knowledge that arrhythmias in the heart, in a planet's rotation, or in a global weather pattern are cause for tremendous concern. Erratic rhythms are highly problematic because they offset the consistency necessary for interdependence to take place. The planet and its people do better with stable, periodic rhythms—internally and externally.

Fortunately, periodic rhythms are everywhere. In water, air, solid matter, and organic life cells, vibrations are twirling, pulsing, pushed, and pulled with an ongoing, steady tempo. Anything that vibrates is susceptible to the influence of the external rhythms around it. This is what makes entrainment so powerful.

COMMON APPLICATIONS OF RHYTHMIC ENTRAINMENT

Strong communication between individuals or among groups may cause entrainment of brain waves. This can sometimes be seen between professors and students, preachers and congregations, and therapists and clients. Audiences entrain to performers, while marching teams and choir members entrain to their compatriots. Other examples of entrainment can be seen in flocks of migrating birds flapping in rhythm and gliding at the same time, fireflies blinking together, college roommates having similar menstrual cycles, and lovers sharing a synchronized heartbeat as they move closer together.

Individually, we entrain to the rhythms around us, be they ocean waves, music, the periodic sounds of machines, or electromagnetic frequency fields. Some nonperiodic rhythmic elements, however, such as traffic, do the oppo-

site of entrainment. They jangle our nervous system, because the brain tries to categorize them. It is looking for the periodicity, or regularity, of the traffic patterns. When it cannot find this neat, organized auditory tonal processing, it acts like a hard drive that can't find a file: it just keeps on searching. This prevents the brain from paying full attention to other sequential functions, such as concentration.

Because we lack full awareness of the effects of all such external rhythms on our systems, our urban sonic environments are generally not the most conducive to health or productivity. Indeed, there are very few places—outside our own homes or cars—where particular attention is given to the rhythms that surround us. The goal of this book is to equip you with the knowledge to create your own healthy sonic environments.

PATTERN IDENTIFICATION (PATTERN)

The brain has so many things to do. Estimates are that the human brain contains 50 to 100 *billion* neurons that pass signals to each other via 1,000 *trillion* synaptic connections. Even with this mind-boggling biological capacity, an ecological process is taking place. The brain looks to use its resources wisely!

Consider the brain as a pattern-seeking machine. Give it a recognizable pattern, and it is happy. As soon as the brain can decipher the pattern, it shifts its *active* attention to that occurrence to *passive* awareness and moves on to the next thing, finds the pattern (into the passive bin with ya!), and moves on again . . . a gazillion times a day! Once an image, sound source, smell, taste, or touch is understood, that sensory data is still on the screen, but is now a passive background event.

One of the foundational concepts of Dr. Alfred Tomatis, arguably the grandfather of modern-day soundwork, is the distinction between active *listening* and passive *hearing*. The visual analog of this would be active *looking* and passive *seeing*. There are times when we want the brain to be in the active mode and times when we want it to be passive. It is this process of balance, back and forth between the two, knowing when and for how long to be active or passive, that makes the difference between one's having neurodevelopmental issues or enjoying a high-functioning, productive lifestyle.

Pattern identification (active/passive) can be defined as the brain's analytical process of identifying a pattern through the senses (visual, auditory, olfactory,

taste, or kinesthetic), thereby enabling cerebral attention to shift from active awareness to passive acknowledgment and move on to the next event.

CONCLUSION

Resonance can be thought of in terms of tone: what is the effect of one pitch on another? Entrainment is essentially the resonance of rhythm: what is the effect of external tempos and rhythms on our internal rhythms? Pattern Identification is the process of moving between active and passive awareness. Employing the concepts of tone, tempo, and pattern gives us naturally effective, inexpensive tools.

Per Tomatis, high tones *charge* the nervous system, and low tones tend to *discharge* the nervous system. The conscious use of rhythm can alter major body pulses, allowing us to be in states most conducive to specific activities. Whether mental productivity, emotional release, or physical sleep is your goal, rhythm is a noninvasive way to wind up or lay back. If you feel out of sync, rhythm can help you find your center and begin again. And pattern identification constantly moves us in, around, and between beta, alpha, and theta brain wave states.

After I concluded a 1999 lecture in Germany, I was approached by a woman who had a very worried tone in her voice. She asked if I wasn't concerned about the misuse of the power of resonance and entrainment. This is a reasonable concern, especially coming from a region where sound was used by Hitler to manipulate the psyche. My response to her concern was that any element can be misused or abused. Unlike processes in the motor system, which can be therapeutically aided by external rhythm, however, many other physiological processes cannot be entrained as effectively by external sensory stimuli. According to Thaut, there is probably a very good protective reason why other cyclical physiological processes (autonomic processes such as heart rate) have only very limited capacity to entrain to external rhythmic cues.[16] If this were not the case, anyone exposed to fast rhythms for a long period would suffer from an overexcited pulse system and drop in his or her tracks. We know that this does not happen.

Look at the example of a dance club or disco. Depending on your mood and state of health, fast and loud rhythms will do one of two things to you—either energize you to dance up a frenzy, sweat a lot, and release endorphins from the exercise, or give you a headache or stomachache and ringing in the

ears from overstimulation of the auditory system. You can choose either to stay and be exposed to loud, fast music or to leave. The body has an inherent wisdom that was originally smart enough to grow from two tiny cells. The built-in protective mechanism that I mentioned previously is there to keep your autonomic nervous system somewhat sheltered from external influences. This does not mean that rhythmic entrainment cannot penetrate; what it means is that some things influence you on a gross level, others more subtly. Music, sound, resonance, entrainment, pattern: subtle influences with powerful possibilities.

Resonance, in all its forms, is the overarching theme of all sound technologies intended to affect your psyche and body. Whether simple or complex, binaural beat frequencies, Tomatis-oriented filtration and gating techniques, pitch, timbre, lyrics, or rhythms . . . their effect is based on how they vibrate your nervous system.

CHAPTER 5

Frequency Medicine

The Work of Alfred Tomatis

Any discussion of the effects of sound would be noticeably incomplete without an exploration of the work of Dr. Alfred Tomatis, one of the leading figures in the field of therapeutic music and sound. Some would call him an ear specialist, but Tomatis was really a frequency researcher, working in the subtle yet powerful domain of vibration and resonance. He prescribed sound frequencies in lieu of pharmaceuticals. His sonic solutions consist of specially reinforced and filtered music and sounds. Most impressive of all, the results achieved by hundreds of busy Tomatis Listening and Learning Centers around the world are startling!

The name Tomatis may someday be a household word like Schweitzer, Freud, or Jung. Over the last fifty years, this French surgeon, ENT specialist, psychologist, and inventor developed a method of retraining the muscles of the middle ear through noninvasive listening techniques. This is so innocent-sounding that it is enough to elicit a yawn. But to those who have suffered from the debilitating effects of learning disabilities, autism, depression, chronic fatigue, or immune system disorders—or for anyone who wants to learn foreign languages faster, communicate better, or improve creativity and on-the-job performance—the work of Tomatis is a lifesaver.

Dr. Timothy Gilmore is a Toronto psychologist who has been actively involved in Tomatis research, evaluation, and clinical application since 1979. Paul Madaule—who with Gilmore founded the Listening Centre—was diagnosed as dyslexic at an early age. He made a remarkable recovery with the help of Tomatis and went on to become a Tomatis practitioner who has helped

thousands of people. In their book *About the Tomatis Method*, Gilmore and Madaule state, "This Method provides a comprehensive approach to communication, language, and the learning process which is based on listening. Dr. Tomatis defines listening chiefly as a process of focusing the ear."*[1]

Tomatis's basic premise is that the primary function of the ear is not communication but, rather, to charge the brain's neocortex with the electrical impulses of sound. He also discovered we can give voice to only the sounds we can hear. If we retrain the way we hear, the result, in simple terms, is a refurnishing of the brain with missing frequencies. These frequency deficiencies are often the root cause of many life-robbing afflictions.

According to Tomatis, the ear is the first fully functioning sensory organ in a fetus; it begins charging the brain—thereby *growing* the brain—by week eighteen in utero. Tomatis also came to understand that we perceive sound in many ways. Not only do we hear with our ears through air conduction, but we hear through bone conduction as well. Tomatis makes the distinction that the ear is not differentiated skin; rather, the skin is differentiated ear. In other words, we hear with the whole body.[2]

THE EAR IN UTERO

Tomatis discovered that the ear is functioning four and a half months before birth and that listening is the first sense we develop. Intermixed with the organic sounds of a mother's heartbeat, circulation, gastrointestinal rumblings, and breath, the unborn child distinctly hears the mother's voice through the fluids of the amniotic sac. Researchers have verified that long before infants speak, they recognize sounds heard prenatally.

Tomatis stated that while in the womb, the higher frequencies of the mother's voice actually nourish the fetus. A pattern establishes itself very early—waiting for this sound, being gratified when it comes, waiting, being gratified, and so on—a process Tomatis called the uterine dialogue. It is with this process that listening begins, and it carries on into childhood. The later

*I am extremely grateful for the investigative work of Paul Madaule in relation to the effects of the Tomatis Method for musicians. As a Frenchman and Tomatis colleague, fully versed in both language and practice, Madaule compiled and translated numerous writings by Tomatis concerning the subject. It appears as a chapter, "The Tomatis Method for Singers and Musicians," in his book *About the Tomatis Method*. Prior to Madaule's work, none of this information was available in English.

development of communication skills, language, learning ability, and (in particular) social adjustment depends on the quality of this early listening. But for a variety of reasons, such listening can be obscured, impaired, or shut down altogether. The Tomatis Method presents a means of retrieving the "open" listening that is our birthright.[3]

If we are robbed of the ability to communicate easily, then learning impairment and social maladjustment are likely. It is well known that learning disabilities are prevalent in the American prison population. Given that methods of early detection and correction of learning disabilities have been inadequate, is it possible that children from stressed or difficult pregnancies, who did not establish the "loop of gratification," fall through the cracks? If indeed the seeds of social behavior are planted in utero, is it any wonder, then, that given the current high percentage of disintegrating family units, we are seeing gangs, violence, and illness like never before?

What did Tomatis suggest we do to remedy this? "I do not treat the children who are brought to me," he said, "I awaken them." He believes, that it is a problem not of *hearing* but of *listening*. While there may be physiological problems that hinder the ability to focus on sounds, the Tomatis Method concentrates on the numerous psychological and social factors that bear on listening, including the family system and emotional background. According to Gilmore, "A child with a reading problem very often presents myriad other difficulties such as short attention span, poor concentration, weakness in oral language, poorly articulated speech, poor vocabulary. Such children are also often immature, with a poor self-concept and sense of self-confidence. They have difficulty adjusting socially to their families and peer groups. Many of these problems affect adults as well."

Listening-related difficulties in children and adults often manifest in diminished learning, speech, language, or communication skills. Difficulty with attention and musicality may also result from listening-related problems.

The Tomatis Method is currently used in more than 250 centers and schools across Europe and North America. Children as well as adults access this revolutionary process of auditory refocusing. Both educational and emotional imbalances are addressed through the unlikely portal of the ear with the music of Mozart. How did this unlikely process come about? The story begins in Paris in the 1940s.

A BRIEF HISTORY

Alfred Tomatis was born in Nice, France, on New Year's Day 1920. His sixteen-year-old mother did not carry the pregnancy with pride. To the contrary, she went to much trouble to prevent her pregnancy from being noticed. Consequently, Tomatis was born two and a half months early.

"It is useless to bother with him, he's dead," were the first words spoken when he was born. Three-pound Alfred was discarded in a basket, left to perish. Had it not been for his paternal grandmother—who had borne twenty-four children herself—Tomatis would have died. The rough start with his mother plagued their relationship for the rest of her life. Fortunately, Tomatis had a strong, loving relationship with his father, Umberto, who was a successful opera singer.

A very sickly child, Tomatis was affected by one particular doctor who was called on to treat him. When faced with a tricky diagnosis, this doctor exclaimed, "I don't know what is wrong with him. I must search for the answer." This level of dedication so impressed the young Tomatis that he decided to become a doctor himself and to search for what he did not know. Unbelievable as it may sound, Umberto Tomatis procured an apartment for his eleven-year-old son. Living completely alone, Tomatis began his studies in Paris. At age nineteen, while a first-year medical student, he was drafted into the French army. The year was 1939. He completed his medical studies in wartime hospitals and clinics and began his first civilian practice in 1945 at the age of twenty-five.[4]

Tomatis's early childhood experiences motivated and defined his lifework. The trauma of his birth led to his exploration of the critical role of sound in the development of the unborn child. His struggle with his mother brought him to understand the lifetime effect of the mother's voice on the fetus and young child. And as the son of a widely acclaimed opera singer, Tomatis was drawn to applying his theories to musicians.

Umberto Tomatis sent many distressed musical colleagues to his young son, Alfred, the new ear, nose, and throat doctor in Paris. After long operatic careers, these singers were experiencing difficulty staying on pitch or producing certain sounds. In the 1940s, the standard prescription for most singers' problems was to treat the larynx with strychnine. Tomatis initially followed this procedure but with no success. In a fit of frustration, he administered the same audiometer tests he had used with munitions factory workers after World War II. To his amazement, he discovered that

both singers and arsenal workers showed diminished hearing at the same frequency level. Clearly, the factory workers' occupational deafness could be attributed to long-term exposure to violently loud explosions. The singers, however, were surrounded by the beautiful sounds of arias and orchestras. Yet the audiometric curves of both groups were stunningly similar and perplexing.

To gather additional information, Tomatis actively sought out and examined as many singers and musicians as he could. A surprising correlation emerged: the amount of time a singer had practiced was directly proportional to the amount of damage to the ear. This manifested in the inability of the singer to hear certain frequencies. It appeared that the longer a singer was at the profession, the worse his or her hearing became. Tomatis's observations were impossible to ignore. Prominent singers were damaging their hearing with the sounds of their own voices!

These findings flew in the face of conventional wisdom, and Tomatis suffered scathing criticism from his medical peers. It was commonly believed that a singer's volume reached no more than a gentle 80 dB; certainly no harm could come to a singer from his own voice. But Tomatis's audiograms were irrefutable; the opera singers and munitions workers both suffered from high-volume occupational hazards.

Faced with this anomaly, Tomatis said, "I did what all researchers do: I ignored all previous discoveries and started from scratch." Again employing a sonometer—the audiometric tool he had used in the munitions factories—Tomatis was able to measure the intensity of sound. To his amazement, he found that professional singers were putting out 80 dB at only half strength! At full vocal power, they could emit between 110 and 140 dB. Tomatis notes, "130 decibels represents 150 decibels inside one's skull. By comparison, a jet engine registers only 132 decibels on the ground." He points out that these figures are all the more extraordinary because decibels are logarithmic, that is, 90 dB is ten times louder than 80 dB. "Though the energy of a singer is not comparable to that of a jet engine," he says, "the intensity of the sound is the same."[3]

While conventional medicine treated pitch difficulties as the result of an overstretched larynx, Tomatis came to see that the problem was in the ear itself. Opera singers were going partially or fully deaf due to the excessive volume of their own sounds. He reasoned that if they were singing poorly, it was because they were hearing poorly. Because of this, they were no longer able to control themselves. To sing well, the subject must have a special per-

ception of the sound being produced. Tomatis reasoned that it was the poor quality of this "self-listening" that was responsible for singers' problems with vocal pitch. Based on this belief, Tomatis abandoned the prevailing theory that the larynx was the primary instrument of singing; rather, he came to see the ear as "the fundamental instrument of utterance."

Tomatis became so adroit at the interpretation of audiometrics that he could pinpoint the range of frequency loss in a subject's hearing by that person's inability to produce sounds in the corresponding frequency range. At this point, Tomatis formulated a concept that was to become the cornerstone for all his subsequent discoveries: "a person can only reproduce vocally what he is capable of hearing." Put more simply, and as Tomatis prefers to say, "One sings with one's ear."

THE NECESSITY OF SELF-LISTENING

Tomatis's breakthrough was to link the psyche to the ability to hear. Not hearing because of difficulty in listening is universally applicable. It seems that the quality of our self-listening determines the quality of our existence on all levels. We cannot reproduce a note that we cannot hear; it follows that if we cannot hear ourselves, we cannot authentically present ourselves to the rest of the world.

Until his death on Christmas Day 2001 at the age of 81, Tomatis maintained that sound is a vital nutrient for our nervous systems. As unborn babies, vulnerable children, or sensitive adults, we unknowingly have the psychological capacity to slowly block out sounds that are displeasing, offensive, or hurtful. This damping is manifested physiologically by a relaxation of the tiny muscles of the middle ear. The net result is a diminution of our ability to hear specific frequency ranges corresponding to the sounds we essentially lock out. This survival mechanism is available to us all, and in most instances, we use it unconsciously.

The Tomatis Method: Focused Listening

The Tomatis Method, consisting of sound stimulation, audiovocal activities, and consultations with a trained professional, can be used to enhance abilities or overcome problems that are listening related.[6] The goal of the method is to achieve the ideal listening ear. Retraining the auditory mechanism of the middle ear can result in focused listening skills.

The retraining is accomplished by listening to specially filtered recordings

of uptempo Mozart and, if possible, the recorded sound of the mother's voice. These sounds come through earphones that have been modified to deliver sound through bone conduction as well as through air conduction to the ear. (In addition to the two transducers for the ears, a third transducer is placed either on top of the head or behind the lower right ear, pressing against the occipital bone of the head.) The special music, the client's own voice, and Gregorian chants are fed through a Tomatis invention known as the Electronic Ear (EE). At the heart of the method, the EE is a device connected to tape cassette or CD players that allows frequencies of 16,000 to 20,000 Hz to be heard.

Billie Thompson of Arizona and Susan Andrews of Louisiana are part of a small group of Americans who have been trained by Tomatis. Thompson comes from a background in education; Andrews had clinical expertise in developmental neuropsychology. Individually, they recognized the intrinsic value of sound stimulation auditory training. After a decade of working with the Tomatis Method in separate listening centers, they describe the function of the Electronic Ear as follows: "The EE can filter recordings of music and voice, and the sound travels through two channels, with different settings. A gating mechanism alternates the sound between the channels when it reaches a specific intensity. The EE is designed to educate the ear to its full functions as a receptor, a mechanism to make subtle discriminations, and an energy generator. The right ear is trained to be the leading or dominant ear, to make for the most efficient processing of speech directly by the speech center in the left hemisphere of the brain."[7]

Through highly specific filters and gating mechanisms, the sounds of the Tomatis Method tonify the muscles and bones of the middle ear, thereby enhancing the ability to focus auditorily. Tomatis believes that "focused listening" is a state preferable to "passive hearing." Hearing is different from listening just as casual looking contrasts with actively seeing.

According to Thompson and Andrews, "Hearing is the passive reception of sound, while listening is the active motivated tuning in and tuning out at choice. Good listening results in well-organized auditory processing and vestibular control of information. Listening plays the fundamental role in processing all language information. The motivational and emotional need for communication begins with listening." Without easy communication, our lives, and the lives of those around us, suffer.

Beginning with a battery of diagnostic procedures consisting of listening tests and interviews with certified Tomatis practitioners, a typical applica-

tion of the method involves sixty to seventy-five hours of listening, in daily sessions of one to two and a half hours.

First intensive: Two full weeks of listening.
Three to six weeks off.
Second intensive: One full week of listening.
Three to six weeks off.
Third intensive: One full week of listening.

The time off between the three listening intensives allows the client the necessary space to experience, integrate, and habituate the new listening patterns.[8] The program is highly individualized and flexible, with the length of each phase and daily listening determined by the client's goals and progress. Both counseling and specialized listening tests note the changes in ear, psyche, and body. According to Thompson, the listening test has parameters and protocols different from those of standard audiology hearing tests. The Tomatis listening test charts air, bone, and spatial perception of sound. Its specific purpose is to assist the practitioner in determining how to work with the client using the Tomatis Method.

There are five basic phases to the method—three considered passive, the other two active. Simply put, the passive phases consist of listening to music and sound with increasing amounts of filtering and processing by the Electronic Ear, then a decreasing of the same process. The purpose is to adjust to the presentation of filtered sound on a gradual basis, develop the focusing response, and stimulate the desire to communicate. Additionally, a "sonic birth" is replicated in order to simulate the transition from the liquid prenatal acoustic environment to the airy postnatal acoustic environment.

In the passive phases, the individual merely listens to sound. In the active phases, the individual participates more fully in the sound training process. This is done by humming, singing, reading aloud, and repeating specific sentences through a microphone into the Electronic Ear. These sounds are then fed back to the ears via earphones. The purpose, according to Gilmore, is to introduce spoken language in the prelinguistic and linguistic stages. Depending on the individual, the tones of the voice may be filtered and gated in the same way that the music was in the passive phases. Additionally, increased stimulation is given to the right ear in order to enhance its dominance: right-ear dominance is a preferred state for audiovocal control.

Tomatis believed that music and vocal sounds rich in high frequencies

have an energizing effect. This corresponds to the effect of the mother's voice on the development of the fetal nervous system. What the unborn child hears are the highest frequencies of the mother's voice, which nourish the fetus in the womb. Consequently, high frequencies still affect us as adults. This is why filtered audiotapes are the backbone of the listening training process. These recordings have all but the high end of sound rolled off; the net effect is listening to the ghost of a musical phrase, replaced with the sounds of sibilants.

One of the foundation concepts of the Tomatis Method is a hypothesis known as the Tomatis Effect, independently confirmed at the Sorbonne in 1957. This effect holds that the voice can produce only what the ear can hear. Therefore, if I sing off-key or speak in a flat, monotone voice, chances are I am unable to hear specific frequency ranges. Thompson and Andrews state, "Two corollaries to the Tomatis Effect led to the development of the Tomatis Method: 1) if the sounds are restored to the ear, they will be immediately restored to the voice, and 2) with sufficient conditioning of one's ear to one's own voice heard with good quality, the changes can be maintained and strengthened."

Additionally, just as there are "charging" sounds that energize the nervous system, there are "discharging" sounds that tend to weaken and fatigue it. Tomatis believed high-frequency sounds—the overtones of music and the voice—energize because of the preponderance of specific cells in the inner-ear membrane that respond to high tones by sending electrical impulses to the brain. Indeed, the number of nerve cells in the cochlea that respond to high-frequency sounds is four times greater than for those stimulated by sounds of under 3,000 Hz.[9]

Consequently, an abundance of lower, bass tones may actually have the effect of overwhelming the system to the point of overload, causing mental and physical fatigue. Overwhelming low, bass tones are a modern-day phenomenon, a result of improvements in amplifiers and sound systems. Prior to this, bass tones (long sound waves) in an open performance context had room to breathe, so to speak. This is very different from the effect of "boom cars" and small performance venues filled with large bass speakers.

The Tomatis Method is a powerfully effective process for change. Treatment for learning disabilities, depression, and immune disorders are not the only reasons people seek out Tomatis practitioners. Some go to correct a stutter, others to improve public speaking. Actors and musicians seek improved vocal and pitch control. Many have learned that foreign-

language acquisition is a matter of retraining the ear. As public awareness of Tomatis's concepts grows, people are using this sonic process for reasons other than "fixing." Increasing numbers come to Tomatis for productivity enhancement or consciousness exploration.

It is odd to think that the ear and how we hear form a psychological portrait of our lives. Yet through the Tomatis tests, an experienced practitioner can tell in which year you might have been sick, separated from a parent, incurred physical or emotional trauma, and much more. As amazing as it sounds, our emotional histories are reflected in our individual frequency spectrums.

The effects of deeper internal listening are uncharted. It seems remarkable that many problems and disabilities can be dissipated by listening to a full spectrum of sound. Yet in my own experience with this method, this indeed has been the case.

DR. RON MINSON

A Healer for the Future

I came from a household with a controlling, angry, and verbally abusive father. He traveled often, but when he was home, he yelled at his family a lot. As a child I learned to essentially *tune him out*. While I minimized the impact of his verbal assaults through the first part of my life, I have paid an adult price within my auditory system because of it.

I was lucky enough to meet Dr. Ron Minson in Denver, Colorado. Minson, a board-certified psychiatrist, had spent twenty-five years directing behavioral and therapeutic activities for major medical institutions, consulting for mental health organizations, and maintaining a large private practice. But when his adopted daughter became deeply despondent dealing with the burdens of learning disabilities and lifelong depression, Minson found his traditional tools unable to quell her rapid and life-threatening decline.

Minson's daughter was suffering from symptoms endemic to adopted children. According to Tomatis, when a baby is separated from its mother, the vital sound connection between the pair is severed. While outer nutrition can be supplied elsewhere, this sonic lifeline is a critical biological connection. Sometimes aural transference to another mother can take place; often it doesn't. Tomatis speaks of the *uterine dialogue,* a postbirth sonic connection between mother and child that has a tremendous effect on the psychological outreach of a newborn. These early tendencies to either reach

out or pull in can then manifest throughout life, in learning disabilities, for instance, depression, poor self-esteem, or unstable health.[10]

In his quest for an effective treatment for his beloved daughter, Minson came across the Tomatis Method. He and his daughter simultaneously went through the process with Thompson at her Sound Listening and Learning Center in Phoenix, Arizona. Both daughter and father experienced such dramatic positive results that Minson shuttered his practice, hurriedly learned French, and went to Paris to study directly with Tomatis. On returning to Denver, Minson set up a Tomatis Listening Center in 1990.

As is so often the case with alternative therapies, the going was slow in the beginning for the new clinic. But as word spread of the success of its treatment programs, Minson's Center for InnerChange began to boom. A more gentle and respectful environment would be hard to find. Minson's marriage of traditional Western medicine with the breakthrough technology of the Tomatis Method and other modalities is not only effective but also, indeed, exemplary.

TURNING MY WORLD ON ITS EAR

When I underwent the Tomatis Method, my listening tests showed severe dips in the 1,500 Hz range. (Listening tests are conducted every four or five days to chart the progress of the Tomatis Method. Necessary sound processing changes—more or less filtration, quicker or slower amplitude gating—with music and voice are made based on these tests and on interviews with attending therapists.)

Among other things, this range corresponds to the frequency of an adult male voice. Not only had I auditorily locked out my father, but I had also shut down my ability to clearly hear anyone or anything in his range.

As I review my childhood and adult years, a long history of difficulties with male authority figures emerges as a significant pattern affecting decisions and choices. It stands to reason that not only could I not hear others in this adult male range, but that I have also had a problem hearing my own voice—literally and metaphorically.

By the end of the Tomatis program—and as my listening tests showed—the hearing dip at 1,500 Hz was basically gone. Since I've completed the method, I find that relating to my elderly father is no longer a problem. For the first time, I feel I can hear what he is saying when he speaks. Also, I notice that I now crave contact with male friends. And I am hearing myself

more clearly than ever. This manifests as greatly increased clarity in professional and personal choices.

At the center, one of the things I hoped to remedy was a tendency to sing off-key in a certain range. As a musician, not to be able to hold pitch embarrassed me greatly. I had even stopped singing. What I didn't know was that I didn't hear the notes in this range because I had shut down that part of the frequency spectrum. After completing the method, I find my pitch is much improved; finding the time to sing may be my only remaining challenge.

Ostensibly, I came to the program out of professional curiosity. In truth, I was looking to see if this cutting-edge concept would help me break tired patterns—balance all my fairly common hang-ups. After some seventy-five hours on the Electronic Ear, I came out a changed man. Yes, I still have challenges, but something inextricably moved. Increased concentration, improved pitch, better memory, stronger language skills, and enhanced dexterity just scratch the surface of what I have experienced as the result of the method. Certainly after mainlining high-frequency matrices directly into my brain, I would expect greater mental agility. But to me, the real goods lie deeper. It has been five years now since I completed the program, and I am still awed by the depth to which this work goes. I don't think you ever *finish* Tomatis work, for it is actually a retooling of the human mechanism. Poor listening can begin at any age and for any number of reasons—major lifestyle disruption, extreme stress, a health problem, or an accident. Auditory retraining and sound stimulation are ongoing tools for staying healthy and centered.

The work of Tomatis has changed the way that I listen. And *listening,* in the Tomatis context, refers to how I process the sonic nutrients around me and how I listen to myself. I am not referring to increased intuition, awareness of long-buried feelings, or receptivity to channeled beings from Mars. Rather, I refer simply to how I listen.

My inner and outer ears are now attuned in such a way that I notice *hearing* the energy behind words, feelings, and sounds. I have always been sensitive, but this is a quantum leap in perception. The power of the subtlety is immense. And the beauty of this process is that the more I listen to myself, the easier it is for me to really hear the truth of things. This sonic energy somehow allows a painless detachment to take place. I don't have to process my "stuff" inside and out. It seems that by hearing a fuller spectrum of sound, I can now hear a fuller spectrum of my internal engines. Thankfully, some of the things that used to be terribly painful in my life no longer hold such a charge.

By the nature of the modality of vibrational healing, subtle and obvious changes go hand in hand. All physical matter resonates, so using sound to reharmonize our systems is logical. There are still many things not understood about the medium and its varied effects, but its results are irrefutable—whether or not we rationally understand every detail.

Tomatis laid the theoretical foundation on which the emerging field of soundwork rests. His concepts and theories cause us to reconsider the awesome power of music and sound.

Core Principles of Alfred Tomatis

- The primary function of the ear is to convert sound waves to electrochemical impulses that charge the neocortex of the brain.
- Sound is a nutrient; we can either charge or discharge the nervous system by the sounds we take in through both air and bone conduction.
- There is a distinction between *hearing* and *listening*. The two are related, but distinct, processes. Hearing is passive; listening is active. This corresponds to the difference between *seeing* and *looking*. Listening and looking are active focusing processes.
- The quality of an individual's listening ability will affect both spoken and written language development; listening ability also influences communication, thereby shaping the individual's social development, confidence, and self-image.
- The active process of listening can be enhanced or refocused by auditory stimulation using musical and vocal sounds rich in high frequencies. This entails the use of filtered and enhanced audiotapes employing the music of Mozart and Gregorian chant. Additionally, Tomatis has invented a device known as the Electronic Ear. One of its functions, accomplished through the effects of electronic gates and filters, is to reestablish the right ear as the dominant ear of hearing.
- Communication is a process that begins in utero. The unborn child hears as early as the fourth month after conception. Sound actually helps grow the fetus's brain and nervous system.
- We can duplicate only the sounds we can hear. This is known as the Tomatis Effect.

Additional in-depth Tomatis-oriented material will be found in this book! See *Sound Stimulation/Filtration & Gating* (chapter 15).

For an updated list of Tomatis-work devices, companies, and trainings, see ThePowerOfSound.com/Tomatis.

Interested in the impact of the Tomatis Method on musicians? See *Tomatis: Revising the Map of the Musician's Odyssey,* located at ThePowerOfSound.com/MusiciansOdyssey. Included are five interviews with musicians about their Tomatis experience and the ensuing impact on their creative work.

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PART TWO

Sound Awareness

CHAPTER 6

A New Awareness of Sound

The prenatal research of Alfred Tomatis shows the hearing mechanism of the unborn child to be functional and alert five months prior to birth. The constant swoosh of blood flow, the thumping of heartbeats, the high-frequency sound of the mother's ever-present voice, and the father's lower voice make up the soundscape of the womb. The sound levels inside the uterus actually get as high as 95 dB with every heartbeat. This is like being on the dance floor of a loud rock club on a Saturday night! As another point of comparison, a regular conversation between two people registers at 40 dB.[1]

So much for the notion of fetal tranquility. The fact is that very early on, we learn to tolerate noise. Fortunately, we have the neural facility to adapt, filter, isolate, and even ignore sound. A colleague who works with autistic children tells me that these kids often do not have a functional auditory filtering mechanism; consequently, many are so sound sensitive that they painfully hear the electricity in the walls.

We are not equipped with earlids, so we take in every sound around us. We may not be consciously aware of it, but the brain is analyzing every sound that vibrates against the eardrum. Our reptilian brain, the locus of an ever-present survival instinct, uses sound to assess safety. Our auditory system is always in a state of alertness. This does not mean that we are consciously listening to all the sounds we hear, but that the auditory mechanism is perpetually processing. Imagine a computer that is on twenty-four hours a day,

tuned with highly sensitive sound perception software to analyze the slightest disturbance of silence. This is the level of attention our auditory system maintains throughout our lives.

An emphasis on creating well-thought-out sonic environments is uncommon in our culture. Very few people consider the cerebral energy that is expended sorting out "garbage" sonic information. You may have noticed the effect of walking into a store or dining in a restaurant where sound is omnipresent. It may work positively; you comment on how nice the place is and go on with your task. Conversely, if the soundspace rubs you the wrong way, you might decide to shop elsewhere or end up eating your meal feeling distracted and imposed upon.* If your primary response to a particular sound environment is irritation, the natural instinct is to remove yourself or the offending stimulus. In our noisy culture, however, we often cannot remove ourselves from sound irritants—be they in the home, office, restaurant, or shopping mall. The result is that we begin to shut down our internal hearing mechanism as a means of coping. This defense mechanism works when we need an escape or less input on the physical as well as the psychological level.†

"Calling noise a nuisance is like calling smog an inconvenience," states William H. Stewart, a former U.S. surgeon general, who suggests that "noise must be considered a hazard to the health of people everywhere."[2]

A new awareness of sound allows us to function fully in our society, noisy or not. The goal in life is to be an open, self-expressive, and healthy human being. We are equipped with the ability to *recycle* energy, be it food, light,

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*An encouraging sign of emerging sound awareness is evident in my local newspaper, the *San Francisco Chronicle*. In its restaurant section, a rating system now includes sound ambience in addition to price and overall quality. The sound rankings include "pleasantly quiet" (under 65 dB), "can talk easily" (65–70), "talking normally gets difficult" (70–75), "can talk only in raised voices" (75–80), and "too noisy for normal conversation" (80-plus).

†A case in point: I was riding on a bus in upstate New York when an elderly couple boarded. While the bus was in motion, the woman insisted on approaching the bus driver and asking him questions. She had a loud, high-pitched voice and an obnoxious manner. The driver asked her to sit down, referring to the CAUTION signs about interfering with the driver when the bus was in motion. This scenario was repeated another few times within the first hour, until the driver pulled the bus over and publicly rebuked the woman. Between each visit to the driver, she talked incessantly at her husband. I noticed that there was very little dialogue between the two. When we finally reached their destination, and as they walked by, I noticed that the man had large hearing aids on both ears. The question arises: *Did she talk this way because he was hard of hearing, or was he nearly deaf to avoid the sound of her voice?*

or sound. These elements contain frequencies that can either energize or de-energize us.

If we become overloaded with sound, our systems begin to close down. The long-term effect is barely noticeable. Our ever-adaptive mind and body come to accept the shutting-down state as normal. Over a period of time, however, we begin to notice that we don't hear as well as we used to, we might be easily fatigued, or our focus seems scattered. A volume dial has somehow been turned down, and we didn't even notice. Then one day we wondered how it had grown so quiet around us.

STRESS-INDUCED AUDITORY DYSFUNCTION

Auditory dysfunction is a very broad topic. Throughout part 1 of *The Power of Sound*, I explored the nature of sound and hearing. I also looked at the role of sound and listening through the filters of Tomatis, Doman, and others. When we put together the many pieces of auditory function, we see that the system has a greater importance than is commonly ascribed to it.

Popular perception of outer- and inner-ear function has centered on the interpretation of sound and the maintenance of balance. However, we now see greater ramifications when the auditory mechanism is not in full working order. If indeed sound is a vital stimulant for the nervous system, then the ear is the portal and the auditory system the delivery mechanism. Just as arteries and veins are vascular highways through which blood carries information, the auditory system is a fiber-optic network for the dissemination of sound impulse and energy.

In the following chapter, "Sonic Safety," I examine how noise damages the ear in two ways: acoustic trauma and noise-induced hearing loss. Be it a sudden shotgun blast or long-term exposure to high levels of noise, our auditory function can be affected—and often greatly diminished.

Noise, however, is not the only postbirth threat to normal auditory function. Childhood ear infections and illnesses, middle-ear fluid, and allergies can also contribute to diminished abilities. The work of both Alfred Tomatis, whose great contributions were discussed in part 1 of this book, and Robert Doman, whose work is touched on in this chapter and again in chapter 15, focuses on the remediation of auditory tonal processing.

The Tomatis concepts consider auditory function from a psychological viewpoint as well as a physiologic one. He speaks of the two muscles of the middle ear becoming flaccid when we shut out or shut down sounds we can't

tolerate. As I explored Tomatis's thoughts about the impact of psychology on the ear, I began to wonder if additional layers of complexity could be laid down by stress and trauma. Two things tipped me off to this—personal experience and passing references within broader articles.

After a few years of extreme, compacted emotional stress—loss of community, loss of employment, premature birth of a child, tax audits, broken marriage—I began to notice aspects of my personality beginning to change. Mentally, I was slowing down in my thought processing. I was not quite so sharp. I began mixing up letters when I typed at the computer—something that had never happened before. Also, I seemed to be having difficulty not taking everyday occurrences personally; as time went by, I was becoming emotionally overreactive. I felt like I was suffering from post-traumatic stress syndrome, even though I didn't know what the actual symptoms of that disorder are. I felt like I had been through a war, and my nervous system was showing the effect.

While researching *The Power of Sound*, I found an article titled "The Emerging Field of Sound Training," by Tomatis practitioners Billie Thompson and Susan Andrews. In their comprehensive, eight-page piece, two sentences were of particular interest: "Poor listening can begin at any age and for any number of reasons. It might result from a health problem, an accident, a major lifestyle disruption, or from stress."[3] Because this was not the focus of their article (published in 1999), Thompson and Andrews left the coverage of stress and quickly moved on to other sound training topics.

Shortly thereafter I read an article by Robert Doman Jr., written in 1982, titled "Dominance and Emotionality." Once again I came across a solitary, one-sentence reference to stress and the auditory system: "Abnormal neurodevelopment may be caused by psychological, physiological, or environmental problems in childhood; deviations of a normal auditory development may also occur later in life due to stress or trauma."[4]

Given a sensitivity to this topic, I was rapt with attention. Yet very few people were talking about it; the two references were all I could find. What is happening to auditory function due to stress and trauma? When we experience loss—be it family, job, money, or health—how does that manifest in auditory function, and what is the broader impact?

ThePowerOfSound.com/SIAD

AUDITORY CROSS DOMINANCE—A POINT OF INQUIRY

One aspect of stress-induced auditory dysfunction that I find to be quite interesting revolves around laterality and auditory cross dominance, two topics that make my professional therapeutic associates cringe. "What is laterality? Nothing is simpler and nothing is more obscure," notes Tomatis. He concludes, "By laterality we mean the fact of being right-handed or left-handed."[5] *Lateral preference* is defined as "the predominant use of one side of the body over the other."[6]

In addition to right- or left-handedness, the concept of laterality includes feet, eyes, and ears. In most normal neurodevelopment, you are either right or left dominant. This means that if I am right-handed, I should ostensibly "lead" with my right foot, right eye, and right ear. Conversely, if I were left-handed, the same elements would line up on the left.

I have learned that the field of laterality is fraught with exceptions and disagreements. As a composer and producer, it is definitely not appropriate for me to state facts or offer opinions about a difficult aspect of human anatomy in which I have no training. Still, once I was buoyed by a few brief professional references to the effects of stress and audition, I engaged in an inquiry into the effects of laterality and auditory cross dominance.

Auditory cross dominance refers to a process whereby a right-handed person, with right-sided dominance, has a left-leading ear (or vice versa if left-handed). I have been told emphatically that there are no firm data on this phenomenon—only clinical observation. I have also been told of numerous gray areas concerning cross dominance, the least of which is the difficulty of scientific verification. Nonetheless, as I travel and teach internationally, I have the occasion to speak with various health care practitioners who work with the auditory system. When I informally broach the topic of auditory cross dominance, I am, without exception, met with nodding heads. It is from this context that I humbly introduce the following discussion.

Robert J. Doman Jr. comes from a lineage of medical and psychological mavericks, so it is no surprise that he dares walk into the zone of laterality and cross dominance. The following excerpt from his article titled "Dominance and Emotionality" was, as I noted above, one of the tip-offs for me that something was going on around the issue of stress and hearing . . . something worthy of further scientific exploration.

The final stage in developing neurological organization—neurological efficiency is the establishment of cortical hemispheric dominance. Cortical hemisphere dominance refers to the establishment of a controlling hemisphere of the brain, separation of, or specialization of neurological function. This separation of function is possible when dominance has been achieved.

Dominance, that factor which permits cortical specialization, exists at such time when the individual has a dominant hand, eye, ear, and foot, which are all on the same side. Specifically, the right-handed individual need also be right eyed, eared, and footed, the left-handed individual left eyed, eared, and footed.

Much has been written in the last few years relative to the specific functions of the dominant and subdominant hemispheres, the dominant hemisphere being that which is on the opposite side of the dominant hand, eye, ear, and foot. The person with right-sided dominance has a dominant left hemisphere, the person with left-sided dominance, a dominant right hemisphere.

One significant function relative to learning, which has not been mentioned in most of the literature, is emotionality. As is music (it is not difficult to see the correlation between music and emotionality), emotionality is a subdominant hemisphere function.

Emotionality in the neurologically organized individual is controlled, it being subdominant. One of the problems associated with neurological disorganization is the lack of later dominance, lack of separation, and specifically relative to emotionality, lack of control of emotionality. In the disorganized individual, subdominant tends to control dominant, as opposed to the appropriate dominant control or balance. This lack of control is significant for all individuals with neurological disorganization.

Disorganized adults often (mental institutions are full of people who cannot) learn to cope by creating conscious controls of emotionality. They develop screens between themselves and others, and often appear to be non-emotional because they have learned that they can either fight off emotion or become virtually engulfed by their emotionality. These individuals are forced to live their lives limiting emotionality and protecting themselves.

We have learned to accept our inefficiencies, spending our lives with the pressures of attempting to cope with our problems, when solutions are available. Thousand of hours are spent in academic remediation, counseling, analysis, and thousands of dollars on medications to help us cope with

neurological inefficiencies which may be easily eliminated if we address and treat the cause.

An understanding of the relationship between neurological disorganization, dominance, and emotionality can dramatically improve many aspects of our lives, as well as those of our children.[7]

Doman's observations come after working with thousands of children and adults. As a journalist, I pose these questions:

- Is there an effect of stress or trauma on the auditory system?
- What are the psychological issues that manifest themselves in the ear?
- How do they manifest?
- What is the effect of auditory cross dominance?
- What scientific basis is there for this?
- What causes mixed laterality, and what are the solutions?
- What are the symptoms, and how are they usually treated?
- Why is stress-related auditory dysfunction rarely spoken about?
- Could auditory cross dominance contribute to a country full of adults on Prozac and children on Ritalin?

For answers, I turned to three professionals who work with sound as a core medium of treatment. Interviews with Billie Thompson, Ph.D., Ron Minson, M.D., and Robert J. Doman Jr. can be found online at www.ThePowerOfSound.com/SIAD and should be regarded as a continuation of this inquiry.

Within the larger context of audition, the subset issue of stress and auditory perception is microscopic. It appears that little attention has been paid to this important link. Yet every Tomatis practitioner will confirm that the psychological component of auditory function is significant, as will most occupational and speech and language therapists. For most of us, the *physiological* health of our hearing is never addressed until we notice that something is changing. Who among us has even considered the impact of our *psychological* state on our auditory system? This is a new way of thinking about sound, hearing, and human functionality.

In the future, our culture will understand sound as fuel and the ear as a portal for charging the nervous system. We will give our ears timely attention. We will tend to our auditory health just as we do our hearts, our eyes,

and our teeth. In order for this shift in awareness to take place, we must understand that proper auditory function is not simply about passive hearing or balance. It is about the ability to engage in "active listening." This facilitates the loop of language, education, communication, and social interaction. There is no aspect of normal living—home, family, employment—that is not dependent on these skills.

Sound is a nutrient for the nervous system. The goal is to learn how to use sound with the same awareness we would apply to food or drink. Moving from the psychological to the physiological impact of sound, let's take a look at the major body pulse systems. Understanding these systems, we can apply the principles of resonance and entrainment in our daily lives to support health and well-being.

THE MAJOR BODY PULSES

The heart, breath, and brain constitute the major pulse systems in the body. The beating of the heart not only lends itself to poetic interpretation but also is responsible for propelling vital blood throughout the physical mechanism. Without the proper intake and exhalation of air in the lungs, we would quickly perish. Finally, the electrochemical balance and tempos of our neurotransmitters allow our brains to monitor millions of events every second and coordinate a multitude of biologic systems.[8] Clearly, the proper functioning of these three systems is necessary for health. The mechanisms of the heart, breath, and brain are ideal subjects for the study of rhythmic entrainment: these systems are so conspicuously rhythmic that they are the perfect organs for resonant attention.

The Heart

One of the largest structures of the body, the heart and its arterial and venous systems move the blood throughout the entire human body. The pulsing of the heart is produced by the alternating contraction (systole) and relaxation (diastole) of the heart muscle.

The heart begins its life-giving task shortly after conception and continues until the moment that we die. According to master drummer and sound researcher Reinhard Flatischler, our mother's heartbeat "is the first rhythmic expression to shape our consciousness." We gestate for nine months within this elemental pulsation, and forever after "there exists a pulsation within ourselves which embodies a specific tempo which relates to all other pulsations."[9]

So the pulse rate that we inherit from our mother, and her mother, and genetic generations before, becomes our major rhythm filter. Our levels of comfort, flexibility, and rigidity are tied to how close or far we are willing to venture from this major pacesetter.

The normal, relaxed heart will beat between sixty and eighty times per minute. The continuous rhythm of the heart may run as low as fifty beats per minute (bpm) among athletes or go as high as two hundred bpm or more during illness or fever.[10] According to Flatischler, both the sympathetic and the parasympathetic nervous systems are in control of the rhythm of the heartbeat. "One stimulates, the other inhibits," he says. "The heartbeat is thus imbedded in the forces at work in our nervous system. But the final origin of this rhythmic power still remains a mystery."[11]

The source for the beating of the heart comes from a tiny valve located in the back of the massive heart muscle; this valve provides the electrical charge that makes the heart beat. As Flatischler notes, no one knows where the electrical charge comes from.

The heartbeat has had a strong influence on the tempo of music. Prior to the invention of the metronome, musical tempi were determined by the human pulse.[12] The difference between a slower adagio and a frenetic beat in music depends on how far it departs on one side or the other from the human heartbeat. Push up the tempo, and you have military music; slow it down, and you fall asleep.

Flatischler spends his life traveling the world studying rhythm. Crossing the boundaries of all cultures, he has found that the body and its rhythms play a central role in music. Thus we find "a knowledge of the inner pulse in the music of all cultures." The melody of the heartbeat is imitated by drummers globally, from the Native American medicine men to the Japanese *taiko*. Highly complex eastern Indian rhythms are based on the heartbeat, using three tempo ranges that are multiples of the normal heart rate. In African, Latin American, and Asian music, the pulse rate is clearly perceptible. Flatischler points out that Western classical music is no exception; music characterized by *tactus intger valor* (a fixed tempo of fifty to eighty bpm) was found in European music from the mid-fifteenth century until the end of the sixteenth century.[13] This tempo, corresponding to a slow to normal heartbeat, was the pulse underlying Bach's music.

The Breath

Normal breathing varies between twelve and twenty cycles per minute (cpm), which is three to five seconds per cycle. This changes in tempo with exercise and relaxation. Breathing can be slowed down during relaxation or sleep to cycles lasting six to eight seconds.[14] There is a reason that we feel so good at the seashore: the rhythm of the breaking waves often produces a relaxing cycle of eight seconds, to which our breath rate entrains. This rate corresponds to the speed of our breath in deep relaxation. It is an excellent example of elemental entrainment.

Inhalation and exhalation are most often thought of as the sum total of the breathing process, but the rhythm of breathing is threefold. Many believe that the true point of power lies in the moment of stillness between breaths, an awareness of which we can cultivate. The moment of stillness is that instant that begins to expand—as though by itself—when we detach ourselves from activity and enter deeper levels of consciousness, as in sleep or meditation. As we allow ourselves to go deeper into this breathing process, we will find that the "letting-be" cycle of stillness becomes as long as the phases of inhalation and exhalation. At this point, we are breathing in a triple cycle rather than a dual cycle.[15]

The dual cycle (inhale, exhale) is most easily observed after a fast run. The triple cycle (inhale, exhale, let be) is most easily observed watching someone in deep sleep. Flatischler believes that the dual cycle is associated with an active, extroverted attitude, while the triple cycle is a bodily expression of introversion. He believes that "duple time and triple time—two elementary phenomena in the music of every culture—are rooted in our physiology."[16]

The corresponding use of rhythm to affect human physiology lies in the relationship to duple and triple time. Flatischler believes that "rhythms that have three subdividing pulses in each interval make the listener more introverted and bring him or her toward an inner stillness, whereas the intervals containing the movement of 2 or 4 subdividing pulses will direct the listener toward outer movement and greater extroversion."[17]

The Brain

The electrochemical activity of the brain produces electromagnetic waveforms known as brain waves. These waveforms can be objectively measured with sensitive equipment such as an electroencephalograph (EEG). As long as you are alive, these continuous electrical waves circulate throughout your

brain. As with cessation of the heartbeat, the lack of brain wave activity is a sign of death.

Research into brain wave states began in the 1920s and has continued to evolve through the use of biofeedback instruments. Researchers have divided the range of brain wave activity into four categories. Each state can be associated with different mental characteristics, and each has its own recognizable cycle. Therefore, knowing which brain wave state is most conducive to an activity—be it peak output (high beta) or full relaxation (theta)—allows for optimal accomplishment of that activity.

The four major brain wave states are:

1. *Beta waves* (14 to 35 Hz). These are found in the normal, waking state of consciousness. You are alert, with a focus on the everyday activities of the world. Beta waves are also present during states of anxiety, tension, fear, and alarm.
2. *Alpha waves* (8 to 14 Hz). These accompany states of relaxed wakefulness, such as daydreaming and meditation. They are blocked by sensory awareness, conceptual thinking, and strong emotions. Alpha waves generally appear in the occipital region of the brain (the visual cortex) when the eyes are closed.
3. *Theta waves* (4 to 8 Hz). These are found in near-unconscious states, very deep meditation, and as you drift into or out of sleep. This rhythm has been connected to states of reverie and hypnogogic states that produce dreamlike imagery. It is difficult to maintain this state without training in the disciplines of meditation.
4. *Delta waves* (0.5 to 4 Hz). Found in the deepest part of the sleep cycle and in unconsciousness, these are the longest and slowest waves.

At any given time, the brain is not functioning in just one level of brain wave activity; it is the combination of these brain wave states that determines the focus of our activities. According to Anna Wise, an internationally respected brain wave feedback expert, "Each state that you experience entails a symphony of brain waves, with each frequency playing its own characteristic part. Out of these symphonies come the art of Picasso, the dance of Martha Graham, the architecture of Frank Lloyd Wright, and the theories of Einstein."[18] The interrelationship of brain wave frequencies is what contributes to our various states of mental and subconscious awareness.

Brain waves work in partnership with the heart rate and the breath rate,

and all three body pulses are susceptible to the powerful effects of rhythmic entrainment.

Even within our bodies, the natural heart rate, respiration, and brain-wave cycles all entrain with each other. If we slow down our breath, the heart rate and brain waves will follow; if we slow our brain waves, heart rate and respiration will follow. The three pulses form a large, rhythmic loop, with each pulse system completely interdependent on the rhythms of the other two.

Listening to music through headphones causes entrainment to take place in the brain first, with the heart and lungs following. In an aerobics class, due to the rhythmic movement, the heart most likely is first affected, with the lungs and brain following suit. Likewise, the breath may become the lead entrainment pulse during yoga-style breathing exercises or while listening to Gregorian chant.*

CONCLUSION

What do I do with this information? you may be asking. If you are a musician or music producer, you will take these rhythms into account when you produce application-specific sound tracks. Knowledge of body rhythms helps you identify the specific sonic neurotechnologies that will help you coax the body to the tempo most conducive to an activity.

If you are a layperson looking to use music and sound with greater awareness, this information can reintroduce you to rhythms that have been going on in your body since the day you were born—or even before! Your body knows all about these rhythms; it doesn't even think about them but just autonomically controls them. In this chapter I have proposed that *you start thinking about this unconscious process.* By making it conscious, knowing which body rhythms are most conducive to a certain activity, you have an edge. You are learning how to use your body with your conscious mind. It's

*Gregorian chant affects us in two ways. Each line is as long as a full breath. After a few minutes, listeners start to slow down their breath rates to match those of the singers. Natural entrainment at work! Another effect of Gregorian chant is the "charging" effect of the tenor voices. Tomatis recommends the use of chant instead of two cups of coffee. It has the perfect ingredients to create the body relaxed–mind alert combination identified as ideal for accelerated learning. For further information on the accelerated learning concept, I recommend *Suggestology and Outlines of Suggestopedy* by Dr. Georgi Lozanov. A full citation is listed in the bibliography.

okay to leave the body on autopilot, but it's even more efficient to use your conscious mind with the rest of your body. This is the meaning of developing human potential. Human beings using music, sound, and other forms of frequency to sleep deeper, digest easier, think faster, concentrate longer, and heal. This is evolution.

Why do we need to do these things? would be the logical next question. If we lived in a serene and natural environment, we wouldn't. Our minds would be fresh, unstressed, and vital; our bodies would be well rested, healthy, and strong. Given that we reside in a new century of digital overload, though, the more natural and noninvasive tools we can use, the better.

If we combine an understanding of the vibrational nature of sound with the impact of resonance and entrainment, a picture should emerge of rhythmic beings using external sound to tune their internal rhythms.

Body tuning is not an exact process at this point; there are too many complex things taking place in the body. To imply that listening to music at eighty bpm will cause all systems to immediately meter out at 80 bpm would be making a false claim. Remember, the rhythms of the body are not entraining to outside stimuli only, but constantly to the body's internal rhythms as well. With entrainment, we are looking to operate within natural ranges. The body's pulses, like a little puppy, will follow a friendly rhythm. This is a natural process. And because sound is a subtle energy tool, we need to be even more aware of its impact.

Tomatis practitioner Ron Minson, M.D., agrees with the U.S. surgeon general quoted at the beginning of this chapter. "When we see smog in the air, we become aware of what we are breathing," says Minson. "If people could see noise pollution as they see air pollution, they would never put up with it!" Given that sound is invisible, a strong awareness of the overall effects of sound pollution will serve us in both the short and the long run.

In the following two chapters I will examine sonic safety, explore current research, and make recommendations of positive ways to use music and sound in our lives.

CHAPTER 7

SONIC SAFETY

In tandem with the visual experience of the world, the soundscape is a constant stimulus. Yet disproportionate to its influence, sound ranks as an environmental element to which we pay minimal attention. A growing number of researchers and theorists, however, are making sound—and responsibility for the soundscape—an environmental issue, looking deeply at its power both to disturb and to heal.

Beginning in 1972, government consideration and control of environmental noise was handled by the Environmental Protection Agency's Office of Noise Abatement and Control. This department was closed in 1982, though, and responsibility for noise control was returned to state and local governments.

City residents have long complained about noise: New Yorkers ranked it the number one problem in 1900 and still do so more than a hundred years later.* Even the suburbs offer little escape. They've become an open-air stage for the din of leaf blowers, lawn mowers, garbage trucks, construction equipment, motorcycles, airplanes, and boom cars, those vehicles with more loudspeakers than square feet.

Environmental noise pollution, which began with the Industrial Revolution, is now a nearly ubiquitous problem. Almost no place is free from

*In efforts to make the city of New York a more palatable place to work and live, traffic ordinances were passed in the late 2000s making the honking of horns punishable by a $350 penalty. In a 2008 visit to this great city, I was amazed and delighted to discover the significant difference being out on the streets. A once-noise-noxious environment was eerily quiet. Taxicabs, the primary vehicles in New York, are now somewhat quiet.

excessive noise, with exposure occurring not only on the streets and at work but also at home and even in the hospital.

NOISE

The word *noise* is derived from the Latin *nausea,* meaning "seasickness." *Noise* generally refers to any loud, unmusical, or disagreeable sound. A potential problem arises here, though, as all three adjectives contain a subjective element. What is loud depends on the current state of your audiological health and your personal taste. If you have sustained hearing damage, sounds may register on you as either too soft or too loud—but not on someone with normal hearing. What is unmusical and disagreeable is a matter of taste in music; one person's noise is another's delight.

Here is the current state of American auditory health:

- More than thirty million Americans suffer from hearing loss.
- Exposure to excessive noise, not aging, accounts for 35 percent of hearing loss.
- One out of every eight American kids between the ages of six and nineteen suffers from loss of hearing as a result of using earphones turned to a high volume. A major contributor to this are ear buds and MP3 players.[1]
- The National Institute on Deafness reports that these losses begin as early as the preteen years and can result in sensory deafness, a permanent hearing loss.

DAMAGING NOISE

Noise damages ears in two ways. First, *acoustic trauma* occurs when an extremely loud sound strikes in an instant. One blast from a high-powered rifle can rip apart the ears' inner tissues, irreparably damaging your hearing. The scars that permanently dampen hearing remain. Second, *noise-induced hearing loss* (NIHL) develops insidiously over a period of decades. The most consistent finding in NIHL is injury to or degeneration of the 15,400 hair cells found in the cochlea. Repeated or extended exposure to dangerous noise levels attacks these delicate sensory cells, or cilia, whose job it is to transport airborne vibrations from the inner ear to the brain. The cilia are incapable of regeneration. By the time you get the signal that

something is wrong—a ringing in the ears or a muffling of sounds—some of your cells may have died.[2]

Many things are not yet understood about the auditory mechanism. It is not known, for example, whether abrupt or inflated intensities of sound waves entering the cochlea cause direct mechanical disruption of the sensory nerves, or if a toxic biochemical reaction to the offending sound waves is the cause of damage to the cilia hair cells.

What *is* known, however, is that loud sounds cause constriction of blood vessels in the cochlea. This may result in damaging changes in the inner ear because of a lack of proper blood supply. This injury can be temporary—lasting minutes, hours, or days after the exposure to the noise—or it can be permanent. The loudness of the noise, how many times you were exposed to it, and how susceptible you are to it are the primary factors that contribute to a temporary or permanent hearing loss.[3]

If you have your ears checked by an audiologist, he will tell you that NIHL often begins at twenty-five to thirty years of age. Common symptoms are decreased ability to block out adjacent sounds and hypersensitivity to noise. When hair cells are damaged, sound perception may become jagged instead of smooth; sudden jumps in volume result from gaps in the cochlea's cilia.

My audiologist recently told me that the long-term effects of NIHL are analogous to skating on thin ice. From the surface it all looks the same, but underneath it may be thin; press too hard and you may fall through. With NIHL, an accumulation of cilia-cell damage can manifest over time or in an instant. A sudden very loud sound or a series of loud sound events can cause you to "fall through" into the zone of hearing impairment. Based on the cumulative loss of hair cells, hearing damage can take many forms, including tinnitus (ringing in the ears or noise sensed in the head), hypersesitivity or hyposensitivity to sound volume, and diminution of hearing in specific ranges.

Who is most at risk for NIHL? The obvious candidates are those exposed on a consistent, long-term basis to occupational noise—firefighters, police officers, military personnel, construction and factory workers, musicians, aviation workers, farmers, and truck drivers, to name a few.

But outside the workplace some twenty million Americans are exposed on a regular basis to harmful levels of noise. Airplanes, recreational vehicles, lawn-care equipment, woodworking tools, some household appliances, chain saws, and live or recorded high-volume music are all nonoccupational sources of hazardous noise, and such noise is increasing in our environment every day. Experts have noted a corresponding leap in hearing loss at young ages.

The unexpected culprit: headphones and portable cassette or CD players.

At the Los Angeles-based House Ear Institute, doctors and hearing specialists have studied since 1950 the effects of noise-induced hearing loss. "One important feature of NIHL," they say, "is that it is preventable in all but certain cases of accidental exposure. Legislation and regulations have been enacted that spell out guidelines for protecting workers from hazardous noise levels in the workplace and consumers from hazardous noise during leisure time pursuits."[4]

Laws and rules aside, there is no rehabilitation or twelve-step program for a noise-ravaged ear. All you can do is minimize further damaging exposure and hope that your rock 'n' roll days (or the equivalent thereof) were actually fewer than you now remember. While marked improvements are currently being made in digital hearing aids, they are expensive, and results cannot compare with the original equipment. Best solution: practice safe sonics!

iPods—Auditory Heaven and Hell

When *The Power of Sound* was first published in early 2001, iPods didn't exist. However, with the Apple launch of these stylish, portable media players on October 23, 2001, an unparalleled new paradigm of *listening* began.

A type of digital music player, there are 173 million iPods (as of 2009) intimately vibrating the auditory canals of earthly two-legged inhabitants. Add to this millions of other MP3 players* made by companies other than Apple. The possibilities for conscious soundwork are exponentially opened up by the advent of these personal music players. Music and sound programs are now more widely and easily available than ever before. With an Internet-connected phone, you can download millions of auditory programs from anywhere. Headphones are no longer nerdy, but trendy! This is great for binaural programs and Tomatis-based sound therapies.

It's also great for stroke and dementia patients. In a 2009 article in *The Wall Street Journal,* writer Melinda Beck begins "A Key for Unlocking Memories" with the following:

"One of the raps on iPods is that users tend to close themselves off from other people and retreat into their own private world. But with stroke and dementia patients, iPods and other MP3 players are having just the opposite effect."[5]

*An MP3 player is a digital device that converts digital data to analog, and stores, organizes and plays audio files. Onboard software allows the transfer of audio files between the player and a computer.

She shares stories about a twenty-eight-year-old stroke victim learning to walk and use his hands again, about a fifty-two-year-old construction worker who fell four stories and crushed his larynx, who has now written four hundred songs, and an eighty-five-year-old Alzheimer's patient who listens daily to opera and Yiddish songs and is articulate afterward. What do they have in common? Specially programmed iPods at home.

Dr. Concetta Tomaino, executive director of the Institute for Music and Neurologic Function at Beth Israel Hospital in New York, has created a program for people to donate used iPods that are then loaded with customized playlists and distributed to patients who can't afford their own.

Those who have their own MP3 players can send them to the institute for programming of evocative tunes.[6]

I am sure that I could fill a book with positive stories about how portable music can make a huge difference in people's lives and the imaginative ways that this new distribution system of sound is being used. However, the effects of improper usage of iPods continue to surface, and I feel that this is a vitally important area to focus on.

Auditory damage is significantly increasing due to the overly loud and extended use of MP3 players. Many iPod listeners are drowning their ears in sound. In the past, portable tape cassette and CD players offered music in one-hour chunks; iPods, however, hold thousands of songs that allow for more than fifteen hours of continuous listening between battery charges. Adding to the sonic over-exposure is the popularity of earbuds, small speakers that fit right inside the ear.

Dr. Blake Papsin, otolaryngologist and director of the Cochlear Implant Program at the Hospital for Sick Children observes, "Earbuds are dangerous by design. They are designed to deliver high levels of sound in the ear canal in noisy environments." A 2004 study reported that in-ear earphones produced higher sound levels than over-the-ear headphones.[7] In a study titled *Does Earphone Type Affect Risk for Recreational Noise-induced Hearing Loss?,* lead researcher Brian Fligor concluded that earbuds allow in background noise and so they are turned up significantly higher than over-the-ear or noise cancellation headphones.[8]

Consider these facts and conclusions from additional recent research studies:

- According to a 2009 report from scientists of a European commission on newly identified health risks, after examining the use of personal music players (PMPs), they found one in ten users are at risk of permanent hearing loss if they listen to a PMP at high levels more than one hour a day for five years.[9]
- Researchers at Colorado University and Children's Hospital in Boston found that teens play music louder than adults and are unaware of how loud they are playing it. Cory Portnuff, the lead researcher, cautions, "It's a matter of how high you listen and for how long."[10]
- Teenage boys listen the loudest of all demographic groups.[11]
- Adults with normal hearing and listening skills need a 6-dB signal-to-noise ratio (SNR) to perceive intelligible speech. Adults and young adults prefer a 13-dB signal-to-noise ratio when using any kind of headphone and listening to music. In a research project led by Portnuff, it was found that teenage listening preferences were up to 7 dB higher, to 20 dB.

"Every time you increase a sound level by three decibels, listening for half as long will produce the same amount of hearing loss," says Fligor, of Harvard University.[12] "The kid who cuts my grass uses an iPod. The lawn mower noise is about 80 to 85 decibels. If he likes listening to his iPod 20 decibels above that, he's in the range of 100–105 decibels. At that sound level he shouldn't listen for more than 8 to 15 minutes."

Prolonged listening to loud rock and roll contributed to hearing loss for baby boomers. But the PMPs will cast a far bigger auditory shadow. Papsin points out that across generations, cumulative noise-related hearing loss becomes greater. "Our grandparents had less hearing loss than our parents, and we have more hearing loss than our parents—we live in noisier environments and expose ourselves to more loud music and noise sources."[13]

In response to the concern of hearing damage associated with extended use of the iPod, a lawsuit was launched against Apple in 2006. France has taken rising hearing losses so seriously that they have passed stringent regulations limiting the volume of PMPs to 100 dB. In America, Apple includes cautionary notices with their iPods and offers voluntary upgrades that limit the volume. They suggest you "listen responsibly, think about the volume, and keep track of time."[14]

What can we do to enjoy the marvelous iPod in light of this avalanche of hearing problems?

Be aware of the noise burden you put on your hearing when listening for extended periods at high volumes.

1. Volume: Limit the volume to 60 dB, about two-thirds of the maximum volume.
2. Duration: Audiologists recommend using the device no more than one hour a day. If you listen longer, take frequent listening breaks.
3. Headphones: Sound-isolating or noise-cancellation headphones that fit over the full ear are preferable to earbuds.*
4. Hearing test: Get one if you are experiencing ringing in the ears, muffled sound after iPod listening, or hearing other voices less clearly.

Teenagers, the thrill of engaging in risky behavior may have a higher price than bargained for. Parents, if nothing else, buy your kids over-the-ear headphones. The combination of lengthy duration and earbud delivery is lethal to the inner ear.

A 2009 article written by Alice Park for Time.com ended with a warning that is all too appropriate: "Listen for too high and too long, and you may have to replace those headphones with hearing aids in the not-too-distant future." As with everything, awareness is the key. Responsible listening makes risks controllable.

Bear the following in mind . . . audiologist Angela King explains hearing loss: "People with good hearing have tiny hair cells that line the inner ear and transmit signals to the brain, which it interprets as sound," King explains. When the ear is repeatedly exposed to noise above 80 dB, the cilia hair cells require a rush of blood or oxygen, otherwise "they effectively die. Temporary hearing loss or ringing in the ears (tinnitus) is a sign that hair cells are trying to recover, but over time recovery becomes impossible and hearing is permanently impaired."[15]

Be cool! Enjoy your iPod!

HEALTHY SOUND AWARENESS

Whether or not you have hearing loss, it's never too late to begin using ear protection and practicing hearing conservation. Much as we perceive temperature—one person may be hot, while another is comfortable—each

*Earbuds do not block external noise, so when in a noisy environment, the inclination is to turn the volume up to compensate. The ear's adaptive response allows us to take in louder volumes without noticing. Before long, we are in the danger zone of auditory damage.

individual hears sound a little differently. As a consequence, susceptibility to noise and hearing loss varies widely.[16]

Previous hearing loss does not guard against additional auditory damage. While you may not be aware of it, because of your already diminished perception of harmful levels of sound, further erosion of the organ of Corti can still take place. It is never too late to begin to practice sound awareness.

As I have noted before, sounds are measured in decibels (dB), and each 10 dB increase represents a tenfold increase in sound energy. Thus 90 dB is ten times noisier than 80 dB. Indeed, the exponential nature of decibels is appropriately similar to the Richter scale for earth tremors.

Table 7.1 shows the decibel levels of common noise environments.

TABLE 7.1 DECIBEL LEVELS OF COMMON NOISES

NOISE	DECIBELS
Watch ticking	20
Whisper	30
Average conversation	40
Leaves rustling	40
Quiet neighborhood street	50
Dishwasher, microwave, blower on furnace	60
Alarm clock buzzer	70
City traffic	70
Noisy restaurant	70
Garbage disposal, vacuum cleaner	80
Busy city sidewalk	80
DANGER ZONE	**DECIBELS**
Battery-powered siren on toy ambulance	90
Lawn mower	90
Screaming child	90
Subway platform	100
Power drill, chain saw	100
Blow dryer	100
Snowmobile	100
Automobile horn	110
Snowblower	110

DANGER ZONE	DECIBELS
Noisy video arcade	110
Rock concert	100–130
Boom cars (when turned up)	125–138
Jet engine at 100 feet	130
Gunshot	140
Jackhammer	180

The standard sonic health formula is based on the proportion of amplitude and length of exposure. How loud and for how long are the factors determining whether hearing damage takes place.

In human adults, 80 dB is the maximum sound intensity that will not produce sensorineural loss regardless of duration.[17] In other words, no matter how long you listen to something at 80 dB, you do not have to worry about ear damage. Above 85 dB, you start playing with auditory fire. Cilia cell damage worsens with length of exposure and higher dB levels. With every 10-dB increase in sound, a quantum jump in effect takes place.

The following standard of noise-level safety is based on decibels and time-exposure levels determined in 1971 by the U.S. Department of Labor, Occupational Safety and Health Administration. In 1984, on further research, 90 dB for eight hours was changed to 85 dB. Therefore, use Table 7.2 as an indicator. It was created for the workplace, and the duration per day may be higher than what is truly healthy for your ears.

TABLE 7.2 PERMISSIBLE NOISE EXPOSURES[18]

SOUND LEVEL (IN DECIBELS)	DURATION PER DAY (IN HOURS)
90	8
92	6
95	4
97	3
100	2
102	1.5
105	1
110	0.5
115	0.25 or less

SAFE SONICS

So how do we live in our noisy culture without becoming sound paranoiacs? The goal is to protect our wonderful hearing mechanisms so we can enjoy the beautiful sounds of our planet; it would be a tragedy to lose the ability to perceive the sounds of a flute, our children's laughter, a loved one's voice, and nature. Serious hearing loss does not necessarily substitute silence for other sounds; often they are replaced with tinnitus, or ringing or buzzing sounds in the head. Hearing damage is not something to take lightly. It will affect you for the rest of your life. Here are some precautionary measures.

- *Limit your exposure to sounds over 85 dB.* If you must be around sounds over this level, minimize the amount of time around each exposure and wear ear protection.
- *With headphones, observe the following:* Keep the volume down,* limit yourself to one hour at a time, and let your ears rest. Be extremely careful using headphones when you are exercising or at work (see chapter 9).
- *Give your ears a rest.* Alternate quiet and noisy activities. Don't go directly to a rock club after a loud sports event; wait a few hours before going out in a snowmobile if you work at a noisy job site.

HEARING-PROTECTION DEVICES: EARPLUGS AND EARMUFFS

If you have to shout to be heard, your sonic environment is too loud. Based on intensity and length of exposure, consider adding earplugs or earmuffs to your repertoire of health aids.

Earplugs are available easily and cheaply at any hardware or drugstore. Don't let your kids go to a rock concert without them. (Some organizations routinely pass out earplugs at rock concerts. One such exemplary group is Hearing Education and Awareness for Rockers, or HEAR.) Earplugs are made of foam, silicone, or wax, with noise-reduction levels ranging from

*Most portable stereos can amplify music to as loud as 110 to 130 dB. Over time, many people prefer listening levels that rank within the harmful range. If you listen with headphones to a portable tape or CD player with a ten-digit volume wheel set at 4 or higher, you may be contributing to hearing loss.

20 to 30 dB. Cotton in your ears is a nice concept, but it won't effectively diminish excessive sound waves.

Earmuffs can be found in sporting goods stores. They tend to last longer than earplugs, may afford better protection, and may be more comfortable, depending on the weather. The term *earmuffs* (as in *ear mufflers*) does not refer here to the kind used for warmth; rather, these are special ear protectors specifically designed for protection from loud sound.

Your personal and professional requirements will determine which combination of earplugs and earmuffs can afford you the proper protection. For maximum effectiveness, muffs and plugs must be correctly worn, maintained, and replaced as needed.

Noise-intensive activities that can contribute to NIHL and for which you should take appropriate measures by wearing earplugs or earmuffs and limiting time per exposure include very loud TVs and stereos, leaf blowers, lawn mowers, snowblowers, and power tools in the home; among children's toys, watch out for certain battery-operated cars, sirens on toy ambulances, some musical night lights, and toy vacuum cleaners.

Snowmobiles, jet skis, motorcycles, and model airplanes (if flown indoors), as well as real and toy firearms, are recreational items whose use can lead to NIHL.

CONCLUSION

Because our ears don't actually bleed after a blast of fireworks or a rock concert, we sometimes don't comprehend the self-induced damage. But the cells are hurting inside the inner ear. As mentioned previously, more than thirty million Americans suffer from hearing loss. "About 75 percent of hearing loss in the typical American is caused not by the aging process alone," says William Clark, a senior scientist at the Central Institute for the Deaf in St. Louis, "but by what you've done to your ears throughout your lifetime."[19]

While the concept of hearing protection devices is novel in a nonindustrial setting, it is time to consider using them. Given the increasing noise of Western society and research clearly delineating irreversible noise-induced hearing loss, we would be foolish not to take appropriate measures.

As with secondhand tobacco exposure and increased exposure to ultraviolet light owing to our diminished ozone layer, sound pollution now requires us to take appropriate measures to safeguard an important organ of perception and pleasure. Even if you do not need the earplugs, conscientious sound awareness will go a long way toward preserving your aural well-being.

CHAPTER 8

Neuroscience and Music

In 1993, *neuroscience* was not a common term of interest. Within the 2,662 pages of my trusty Webster's dictionary, a definition of neuroscience was not found. Yet when I do a Web search in 2009, I am offered over 12 million results. *Neuroscience and music* brings 192,000 results.

Neuroscience can be broadly defined as "the study of the brain and nervous system." The Society for Neuroscience* has delineated essential principles of neuroscience:

- The nervous system controls and responds to body functions and directs behavior.
- Nervous system structure and function are determined by both genes and environment throughout life.
- The brain is the foundation of the mind.

We know about the taproot of music that transcends boundaries of time or culture. So, what brings about the intersection of music and neuroscience?

Historically, the scientific study of musical tone perception started with the work of Hermann Helmholtz in 1863.[1] It took another hundred years for the next progression of thought. In 1960, Nobel-Prize-winner Georg

*A U.S.-based nonprofit membership organization of basic scientists and physicians who study the brain and nervous system (www.sfn.org)

von Békésy published *Experiments in Hearing,* and in 1976, Reinier Plomp wrote *Aspects of Tone Sensations.* Noted physicist Juan Roederer, in his *Music and the Evolution of Human Brain Function,* maps the early neurological considerations of music and connects them to the coming neuroscientific avalanche:

"The studies of Helmholtz, von Békésy, and Plomp," he says, "shed light on the perception of individual complex musical tones, tone superpositions and sequences, and fundamental attributes such as pitch, loudness, timbre, consonance, roughness, chroma, tonal dominance and scales." These early studies were designed to quantify sensations of subjects exposed to tone signals in systematic experiments. By correlating the results with the physical parameters of the stimulus, Roederer explains, musical psychoacoustics became a science in its own right.

"Later, the scientific interest shifted more and more to the underlying physiological and neural mechanisms," he says, "particularly to the higher level processing involved in musical imaging (internal hearing and composition) and the affective response to music. This required a truly interdisciplinary approach, with cooperative participation of musicians, physicists, psychologists, physiologists, and neuroscientists."[2]

Michael Thaut is a Fulbright Scholar, a professor of music *and* neuroscience at Colorado State University, and a prodigious music researcher. In the introduction of his book, *Rhythm, Music, and the Brain,* Thaut addresses the confluence of music and brain science:

> With the advent of modern cognitive neuroscience and its new tools of studying the human brain, "live" music as a highly complex, temporally ordered and rule-based sensory language quickly became a fascinating topic of study, probably driven by the quiet hope that these new tools and paradigms would bring us closer to the understanding of the function and role of music and its mechanisms to attract our minds.
>
> In parallel to these aspirations, however, another highly significant development in studying music scientifically occurred, which was possibly less foreseen by many researchers. We now know that by studying the physiology and neurology of brain function in music we can actually obtain a great deal of knowledge about general brain function, in regard to the perception of complex auditory sound stimuli, time and rhythm processing, differential processing of music and language as two aural communication systems, biological substrates of learning versus innate talent

in the arts, and processing of higher cognitive functions related to temporality and emotion.

Music has become a very useful model for brain research in perception and cognition. It has become quite clear in recent years that one of the most interesting and provocative suggestions coming out of these efforts in music and brain science is the realization of music as a biologically deeply ingrained function of the human brain. The brain has neural circuitry that is dedicated to music.[3]

The quantum leap in understanding music and the nervous system, and the ability to administer precise frequencies for specific physiological applications* comes forward through high technology advances of electroencephalography (EEG)—the recording of electrical activity along the scalp produced by the firing of neutrons within the brain[4]—and through the invention of magnetic resonance imaging (MRI).

MRI is primarily a medical imaging technique that uses a magnetic field and pulses of radio wave energy to visualize the internal structure and organs inside the body. Debuting in 1973, MRIs also may show problems that cannot be seen with other imaging methods (X-ray, ultrasound, or computerized tomography [CT] scan). The relationship of the MRI and sound is synchronistic. All soundwork starts with resonance, the ability of one vibrating substance to affect a nearby substance.

Because of the ability to accurately record (EEG) and actually see into a living, functional brain (MRI), neuroscientists have become deeply involved in the evolution of applied sound. Using Google as a guide and *neuroscience and music* as the search terms, the abundance of academic consideration indicates a robust future for intentional sound and music. *To wit, a sampling of what could be a series of volumes . . .*

- Neurologist Oliver Sacks states that music occupies more areas of the brain then language does, and that humans are a primary musical species.[5]
- Psychoanalyst Gilbert Rose argues that our responsiveness to music begins with the nonverbal emotional rapport of the earliest infant-parent interplay.[6]

*High intensity focused ultrasound—a recent medical breakthrough in the use of sound frequencies—is administered in conjunction with the MRI.

- Cognitive neuroscientist Daniel Levitin has determined that "music activates the same parts of the brain and causes the same neurochemical cocktail as a lot of other pleasurable activities like orgasms or eating chocolate—or if you're a gambler winning a bet, or using drugs if you're a drug user. Serotonin and dopamine are both involved."[7]
- Neuroscientist Michael Thaut speaks about the years since 1990 bringing unprecedented development of research in the biomedical sciences of music, which has led to the creation of Neurologic Music Therapy (NMT)—the therapeutic application of music to cognitive, sensory, and motor dysfunction due to neurologic disease of the human nervous system.[8]
- Psychology professor Stefan Koelsch indicates that the human brain processes music and language with overlapping cognitive mechanisms and that musical elements pave the way to linguistic capacities earlier than phonetic elements.[9]
- Music therapist Concetta Tomaino, cofounder of the Institute for Music and Neurologic Function, works with Parkinson's or Alzheimer's patients and individuals suffering the effects of stroke or other brain disorders. "Rhythm can be used to entrain movement when independent movement, initiation, or balance is a problem. The slight change in orientation, for example, following rather than initiating, enables for the function to be attained."[10]
- Neurologist Gottfried Schlaug has identified musicians as ideal examples of the human brain's ability for structural and functional adaptation. Musicians' brains adapt to the special demands of trained performance to allow for such abilities as absolute pitch.[11]
- Developmental psychologist Judy Plantinga and Dr. Laurel J. Trainor, an auditory development lab director, have demonstrated that a two-month-old infant, after becoming familiar with a melody, can remember that tune and distinguish it from a comparable piece of music.[12]
- Neuroscientist Aniruddh D. Patel, after studying a dancing cockatoo that adjusts the tempo of its rhythmic motions to match a change in musical tempo, believes that synchronizing to a musical beat is not a uniquely human behavior.[13]
- Psychology professor Isabelle Peretz says evidence points to the existence of biological foundations for musical emotions, and this may explain why music is an ideal instrument to induce an emotional

reaction, as musical communication of fundamental emotions is a biologically prepared mechanism.[14]

- Psychology professor Petr Janata has located an area just behind the forehead that appears to be a nexus point for music, emotions, and memory. The medial prefrontal cortex has also been identified in other research as one of the last areas to atrophy during Alzheimer's disease.[15]

Music as a Model for Cognitive Function

In 2009, an article titled "How Does the Brain Process Music?" was published in *Clinical Medicine, Journal of the Royal College of Physicians.* J. Warren, a researcher from the National Hospital for Neurology and Neurosurgery in London, wrote about a current phenomenon—how learning about the way the brain organizes and processes music has become of great interest to the contemporary neuroscience community. Due to the increasing sophistication of brain-imaging technologies, neuroscientists have come to see that music processing provides a new model for studying nonverbal brain function.

"The emerging picture is complex but coherent, and moves beyond older ideas of music as the province of a single brain area or hemisphere to the concept of music as a 'whole-brain' phenomenon." Warren writes, "Music engages a distributed set of cortical modules that process different perceptual, cognitive and emotional components with varying selectivity. 'Why' rather than 'how' the brain processes music is a key challenge for the future."[16]

Neuroscience and music—For a list of schools, labs, and updating resources, see: ThePowerOfSound.com/NeuroscienceResources.

CHAPTER 9

Music and Sound in Your Life

TPOS Author note: I recommend using the companion website while you read this chapter. In the twelve categories covered here, there are more than sixty abstracts for your observation online, in addition to what you have on these pages. Given that research is a dynamic medium and always changing, I will continue to add new research in these categories online.

Forty male beer drinkers were observed in a bar . . .

Sounds like a perfect set-up for a joke. However, it actually comes from a 2008 French research study on the effect of music on alcohol consumption. The multiple abstracts referred to in this chapter are from the period of 1973 to 2010. They are not a complete compendium of international research. However, they do represent studies I find relevant, vital, and interesting. Some made me marvel, others made me chuckle; many caused me to scratch my head, and I had to reread a few of these studies several times. All helped me realize how far the scientific research of music has come and the rigorous explorations that lie ahead. An interesting side note . . . some research contradicts others. I include this to show the varied thinking and results concerning this mysterious thing we call music. Wherever possible, I have included online information for further details.

To this point, I have examined the physics of sound and the mechanics of hearing. I have looked at the effect on the body of tone, tempo, and pattern. The elegant theories of Alfred Tomatis shed light on the physiological and

psychological effects of sound stimulation. The advent of a new scientific field of study, music neuroscience, helps us understand the *hows* of music cognition. (The *whys* are yet to come.) Finally, understanding of body pulses and sonic safety issues have brought me to practical suggestions that embrace all of the above topics.

In this chapter, I present compiled research and give recommendations for personal applications of psychoacoustic principles. From "Music for Babies" to "Sound Awareness and the Hospital," my intention is to inspire and intrigue you—and encourage you to do the next great research study on intentional music and sound. Additional categories include: teenagers, seniors, early education, focus and learning, fitness and athletics, workplace, home, car, hospital, and music and the heart.

Be aware of the power of sound and use it consciously. As with any substance, there can be positive and negative applications. *Think of music and sound as thinking people's drugs.* They can enhance, arouse, or depress. Like food, water, wine, sex, and pharmaceuticals, it all comes down to frequency and dosage. The question becomes, *How often and how much?* Applied to the effectiveness of auditory stimulation as well as nervous system balance, the answer is always individual. This is the nature of sound: subtle, powerful, personal.

These recommended selections are offered as a starting place. I believe that given the differences among individual nervous systems, what works well for one may have a different effect on another. Therefore, applying the principles of resonance and entrainment to each individual circumstance is the preferred method of effective sonic prescription. *Think of music and sound as self-help for the nervous system.* Compile your own lists based on personal preference and the intention of the application.

MUSIC FOR BABIES

In 1998, a few states in America actually legislated applications of classical music for infants and young children. In Georgia, every newborn leaves the hospital with a classical CD or cassette—a gift from the state! Florida now requires all its state-funded child care facilities to play classical music every day. What was the genesis of this idea?

Scientists who have studied infant brain development say that infants can develop sensitivity to music as young as four months of age.[1] However,

according to Tomatis, sound processing is not a new function at all for the newborn. He believes the unborn child has been hearing for four and a half months prior to birth.[2] Therefore, once the baby is born and the outer and middle ear switches from liquid to air induction, the baby's auditory mechanism is 100 percent functional.

On birth, a baby's brain is a mass of neurons. The potential for learning physical and mental skills turns into reality as neuronal pathways connect with different sections of the brain. The first few years will determine the child's ability to learn for the rest of his or her life, for during these early years, nerve cells form and connect at an astonishing rate.[3]

The latest research shows that music is actually perceived in many areas of the brain. According to a 1998 study from the University of Texas, music experts determined that rhythm is tracked by the cerebellum, melody perceived by the temporal lobes, and interpretation of musical notation accomplished in areas on the right side of the brain that correspond to areas on the left that process language.[4]

The circuitry for spatial reasoning and mathematics lies in or near the brain's cortex. The function of musical perception takes place in part in the same area. When a baby hears music, it stimulates this part of the brain, resulting in an increase in the newborn's neuronal development. Theoretically, this should lead to better brain functioning in math and spatial reasoning; increased neuronal circuitry is a collateral result of the perception of music. Additionally, language and music are both forms of communication that rely on highly organized variations in pitch, accent, rhythm, and timbre. While these are discrete cognitive systems, both language and music are rich in harmonics, the overtones of a sound that give it resonance and distinction. In language, sounds are combined into patterns—words. Music does the same patterning with melodic phrases.[5]

As reported in *Discover* magazine, in a 1995 experiment by Sandra Trehub, a developmental psychologist at the University of Toronto, repeated intervals were played to six-month-olds, with the intervals raised or lowered occasionally to determine if the infants could decipher the difference in the pattern. They could, especially when the test intervals were perfect fifths or fourths. Clearly, there is an interrelationship between music and language.

It is assumed that by exposing babies to complex musical structures, their brains will by necessity develop neuronal connections. The chemical interaction of neuronal connections is a natural response for the interpretation of

incoming data. In this instance, the data happen to be in sonic form. The fact that math, language, and spatial reasoning skills benefit from neuronal development spurred by musical input is perhaps a happenstance of cerebral neighborhoods. In other words, brain functions that border or share the musical perceptual areas (that part of the brain's real estate, so to speak) may prosper by association.

Music in the Care of the Newborn

By the time the unborn child is six months in utero, the fetus not only hears music but also responds, interacts, differentiates, and even has preferences.[6] Researchers have found that a fetus will jump in rhythm to the beat of an orchestra drum. The unconscious memory of the maternal heartbeat in utero appears to be the reason that a baby is comforted by being held against someone's chest or is lulled to sleep by the steady ticking of a clock. Regardless of culture or caregiver, babies are instinctually held with their heads near the heart. The mother's heartbeat has been the sound that dominated the unborn child's world.

Other voices and familiar sounds add harmony to the progressive composition of the uterine symphony. From the sixteenth week, the unborn child is capable of hearing. The fetus has much to listen to, because the pregnant abdomen and uterus are very noisy places. As you can imagine, the ongoing blood flow through the placenta is a nonstop river of sound. Studies of the newborn's auditory capacity suggest that infants prefer high-pitched voices to low-pitched. This makes sense; mama's voice—in the high frequency range—was an ongoing prebirth phenomenon. You will recall the personal experience of psychiatrist and Tomatis practitioner Ron Minson, who states, "It's well known that there is a higher incidence of learning disabilities in adopted children than in the general population." In Tomatis circles, it is widely held that a baby taken from its natural sonic environment—away from its natural mother—will tend to "close down" instead of the normal reflex of "reaching out." These terms are metaphorical because Tomatis is referring not to an actual physical reaction but to a psychological one that quickly translates into physiological ear and brain manifestations.

In selecting sounds and music for the newborn, consider the type of music that the mother has been listening to prebirth, along with the baby's response to the music. Familiar pieces will assist the infant in feeling secure in an enormously new environment. Much like a child or adult, a newborn seeks familiarity. That which we recognize makes us feel safe.

Recent Research

"Music and Birthing." Researchers determined in this recent study that if music was used as part of the woman's preparation for birth, music therapy was beneficial also during labor. Music, along with a positive mental attitude, helped the woman relax, so she required less medication. This in turn led to a better outcome for the baby, because there was no respiratory depression caused by transplacental transfer of drugs.

During normal deliveries and cesarean sections (under epidural anesthesia) music has a role to play as a distraction, altering pain perception, decreasing anxiety, and being part of the celebration of birth.

"Music May Temper Pain in Preemies." A 2009 study done by researchers at the University of Alberta indicates that playing music for premature infants *may* have the beneficial effects of pain relief and helping the newborns begin oral feeding. Classical pieces and lullabies were played for infants during painful procedures. The children's heart rates and body rhythms were monitored to measure the affects of the music.

The results of this study shows *some* positive results: calmer infants during procedures with more stable heart rates and increases in oral feeding. The researchers acknowledge that music is known to sooth infants; however, in order to demonstrate possible pain-relieving qualities, *scientifically random tests with controls are needed.*[7]

"Effects of the Pacifier Activated Lullaby on Weight Gain of Premature Infants." "Within the past 5 years there has been an increase of premature infants surviving in the neonatal intensive care unit as well as an increasing cost for each day the infant is kept there. It is important for the premature infant to acquire the feeding skills necessary for weight gain, which lead to discharge from the hospital, and recent advancements have indicated the effectiveness in using contingent music to teach sucking skills to premature infants."

The purpose of the first analysis in this 2005 study was to determine the effects of pacifier-activated lullaby (PAL) trials on weight gain of premature infants. During a two-year time period, sixty-two infants from a sample of 188 met criteria for analysis. In a second analysis, weight gained prior to use of PAL, during use of PAL, and after use of PAL was analyzed and definite trends of greater weight gain with PAL use were shown.[8]

ThePowerOfSound.com/BabiesResearch

Additional research includes:

- "Live Music is Beneficial to Preterm Infants in the Neonatal Intensive Care."
- "Music Therapy in the Care of the Premature Newborn."
- "The Impact of Music on Newborn Colic and Circumcision Pain."

Sound Awareness for Babies

Words, math, spatial perception, and music are all intertwined in the brain. You might expect that if you could stimulate one capacity, the others would prosper. Following that line of thinking, why not surround the baby with numeric equations? By stimulating the mathematical part of the brain, wouldn't that also increase the neurons connected with musical processing? Probably not.

The cerebral triggering that occurs through the ears is different from that which occurs through the eyes. Physiology textbook authors readily admit that knowledge of the brain's auditory perception—while advanced—is incomplete. Let it suffice to say that sound and the ear play a role in the development of the nervous system very different from that of the eyes, nose, and mouth.

Classical music for babies? Absolutely. They will learn beauty and form. They will be mesmerized by the sounds; gentle harmonies will soothe them. Perfection exists within complex classical music as well as in the simplicity of a single melodic line.

But which music? you may ask. Using your understanding of entrainment, determine what you would like to accomplish. If you wish to help your baby sleep, use adagio and lento (slow) movements. If you wish to calm an uncomfortable baby, use simple music—pieces with light densities of orchestration, such as acoustic guitar solos and harp and flute duets. It will be easier on the nervous system of a tired parent and child if the sound source is uncomplicated and takes less energy to process. To distract or entertain a little one, pick what you like. Remember, always keep it soft and gentle. Loud, sudden sounds will scare a baby. This is never the goal with music, and it will defeat your purposes in using music to enhance and support.

Best of all . . . sing to your child. Regardless of the magnificence of the classical repertoire, the mother's sweet, loving voice is the ultimate analgesic for a baby. The only thing that comes close is the father's voice, especially if he has been vocally present during the pregnancy. According to Tomatis, the

more a newborn hears the mother's voice, the more the child will reach out for reconnection. This is the best thing for a developing baby.

MUSIC FOR TEENAGERS

The amazing transitional time between childhood and adulthood seems to fall loosely into the category of adolescent years—twelve to nineteen. During these teen years, raging hormones cause the body to change as sexuality emerges. A driver's license allows heretofore-unknown freedom. Social interaction intensifies. Preparation for college causes academic pressures to increase. Choices abound: *What do you like? Who is in charge and why? What do you want to do with your life? When are you going to leave home?* These are big questions that go to the root of security, groundedness, and self-esteem. The soul searching of this time can cause anxiety and produce stress. Finding ways to deal with the quantum changes looming ahead is a well-worn rite of passage. Music and teenagers is a match made in heaven . . . or some might say hell! Let's find out why.

"Music has strong effects on behavior and can do so by communicating moods and emotions." As sound researcher N. M. Weinberger notes, numerous studies attest to music's powerful influence on mood and emotion.[9] According to a renowned pioneer in psychiatric aspects of music, Dr. Peter Ostwald of the University of California, San Francisco, music is "a form of social behavior . . . a symbolic emotional experience."[10] Moreover, music may provide a form of nonverbal communication whose meaning is ineffable; it cannot be captured in words. Perhaps music exists because of the need for expression of emotions that "can only crudely be measured or described in words."[11]

"Therefore," Weinberger concludes, "music can rapidly and powerfully set moods and do so in a way not as easily attained by other means. (Even if adequate to the task, the written word cannot do so as quickly and, when used, often must convey a particular setting, content and visual imagery that itself interferes with or shifts thoughts.)"[12]

Given our understanding of the power of music and its evocation of mood and emotion, there is another piece to add to the puzzle—that of guided imagery. How do words and music together influence us?

There has been much research on this topic. However, one recent study makes a concise statement: music and guided imagery actually alter hormonal output. In a 1996 study titled "The Effect of Selected Classical

Music and Spontaneous Imagery on Plasma ß-Endorphin," researchers explored the effect of music and verbal imagery. They were seeking to determine whether silence, music alone, or music with guided verbal imagery could cause a decline in the secretion of a certain stress hormone. A significant decline in the hormone was found in the group of volunteers that used music and imagery combined. No other group demonstrated any significant changes.[13]

What is guided imagery? Simply put, I would define it as a psychological tool that intentionally uses language to paint conscious and subconscious images for a specific therapeutic effect. This methodology can be used for relaxation, for self-induced healing, or in a psychotherapeutic context. When words are used in conjunction with music that complements the imagery, a very powerful match of verbal and nonverbal cues is sent to the brain. Quite often the creation of a trance state facilitates a deeper induction of the guided imagery. And what can create trance? Rhythm and entrainment.[14]

If we understand the ability of music to elicit emotion and mood, and the ability of words to stimulate and label feelings, a picture emerges of the powerful combination of words, rhythm, and music. Add to the mix a vulnerable teenage psyche and we have a recipe for considerable influence.

Music for Teens Research

ThePowerOfSound.com/TeensResearch

- "Listen Up: Explicit Music Lyrics Can Promote Risky Behavior." (2009)
- "Feeling the Beat: The Meaning of Rap Music for Ethnically Diverse Midwestern College Students." (2007)
- "Differential Gender Effects of Exposure to Rap Music on African Americans." (1995)
- "The Immediate Effects of Homicidal, Suicidal, and Nonviolent Heavy Metal and Rap Songs on the Moods of College Students." (1995)
- "The Influence of Misogynous Rap Music on Sexual Aggression against Women." (1995)
- "The Relationship between Heavy Metal and Rap Music and Adolescent Turmoil: Real or Artifact?" (1994)
- "Adolescent Suicide: Music Preference as an Indicator of Vulnerability." (1992)
- "Adolescents and Their Music." (1989)

- "Adolescents' Interest in and Views of Destructive Themes in Rock Music." (1987)

Sound Awareness for Teens

If you survey the titles of these research studies, you might think that I purposefully looked for the most damning and negative reports I could find. Not so. In my extensive literature reviews of medical and psychology journals (where most recent research is reported), these papers were the sum total of what I discovered. Combing through the popular press (major magazines and daily newspapers), these were the articles I found: "Sonic Boomers: Turning Up the Volume," "Is Rock Music Rotting Our Kids' Minds?," "Rock Doesn't Rot Anybody's Mind . . . But Heavy Metal Just Might," "Midlife Music," "Decibel Disciples: Young-at-Heart Head Bangers and Their Heavy Metal Way of Life," and "Does Rap Music Need a Warning Label?"

With the exception of "Midlife Music," all the articles questioned the negative effects of rock, heavy metal, and rap music. "Rock music has been decried as a scourge of society since it was first introduced to the American public by Bill Haley and The Comets in 1955," states Mary Ballard, a psychology professor and specialist on the impact of the media on adolescents and children. This may be because the foundation of rock 'n' roll was built on defiance, rebellion, and the expression of youthful angst. Ballard continues: "Two subgenres of rock, heavy metal and rap, may best exemplify both the insurgency and the disenfranchisement experienced by many adolescents. At the same time, heavy metal and rap music often embody the worst fears of the parents of this generation's youth, that is, sex, drugs, and violence. Thus these two types of rock music have become the center of a controversy that has reached from the sermons of small town churches to hearings on Capitol Hill."[15]

Sex, drugs, and violence . . . In the 1960s, the famous lifestyle slogan was *"sex, drugs, and rock 'n' roll."* However, much has changed since then. Dangerous sexually transmitted diseases such as AIDS, the stubborn appeal of life-destroying hard drugs such as crack cocaine, and the proliferation of handguns on our streets have all helped to tarnish the appeal of the counterculture's early battle cry. Things are very different for today's children than they were at the time many of us were growing up in the heady days of the original Woodstock festival, which seem almost innocent in retrospect. Music continues to play a unique role, but the stakes are higher now.

Since rock music emerged almost sixty years ago, it remains the auditory

anthem of individuating teenagers. One of the things that has changed, however, is the casual ubiquity of music among today's teens. Due to new technologies such as digital players and lightweight headphones, music now can be a constant companion. In the *Journal of the American Medical Association*'s report "Adolescents and Their Music," Dr. Elizabeth Brown noted that between the seventh and twelfth grades, the average teenager listens to 10,500 hours of rock music, just slightly less than the entire number of hours spent in the classroom from kindergarten through high school.[16]

This statistic is staggering. When my daughter was six years old, I gave her a portable CD player and a dozen carefully chosen CDs. I was not intentionally enrolling her in the music "habit." I wanted to introduce her to the joy of music, for her to discover different styles. I wanted her to know music as a good friend—a place she could go when there are too many words. I selected show tunes, silly tunes, and Irish, Gregorian, and Jewish holiday music. I included world-beat albums for children and musical dramatizations of Mozart, Vivaldi, and Handel. I'd rather she listen to music than sit mindlessly in front of a TV. I think it's important to share one's love of music with children and establish a working dialogue with them about their sensory choices from early on.

Many parents, researchers, and lawmakers draw correlations between escalating violence and graphically sexual or violent rock lyrics. They point out that children with headsets live in an unmonitored world of repetitive suggestion. Many believe that at least TV is a public forum that can be experienced as a family and discussed and processed as such.

Aren't the adolescents who spend 10,500 hours listening to music practicing the art of choice? Aren't free will, preference, and judgment important parts of honing adult skills? In this book, I have spent a great deal of time advocating the intentional use of music and sound. Does anyone force children to listen to something they don't like, or do they gravitate to the music that resonates emotionally or physically for them?

If teenagers have feelings of frustration, rage, and despair, they will find music that addresses those issues. Perhaps this is why the major consumers of heavy metal music are teenage males. What are the issues on a teenage girl's mind? Love, tenderness, "doing it." Who buys the millions of albums made by clean-cut, cute eighteen-year-old male sex symbols? The fourteen-year-old girls. What are the themes of this music? Best friends, love, tenderness, and the like. Recall who did all the screaming at the early Elvis or Beatles concerts.

Segueing to the year 2010, let's examine the effect of heavy metal and rap music from a psychoacoustic vantage point. The primary musical elements of rap are some fairly slow, repetitive rhythms on a drum machine along with lots of up-front bass. This is sonic valium! The rhythm slows the nervous system. The preponderance of bass does not energize the nervous system; rather, it is discharging. Add the lyrics, rapped in a periodic cadence. This style of speaking, along with the rock-steady percussion, facilitates trance. Recall that at the beginning of this section on teens, I spoke about the power of music and guided imagery. Rap music is an extraordinary sonic tool. It contains all the elements of a therapeutic device. The question, however, is whether its guided imagery is positive or if it embraces and imparts negative values. Some of this music is positive and some is not. Rap stars booked on murder charges are not exactly the kind of role model that any parent wants. Yet isn't this situation, one that has overtaken and crossed all racial boundaries, a reflection of our culture? Or is it defining our culture?

Heavy metal follows in many of the same footsteps as rap, with lots of bass but faster rhythms. Where rap seeks to keep it slow and low, heavy metal music accomplishes the same blowout of the nervous system through overload—lots of distortion turned up very loud. The themes of headbanger music tend to be on the negative side. Not much political or social awareness here. Yet who is forcing a fan to listen? What is it about this music that attracts the white teenage male? Aside from the fact that his parents cannot stand it, it makes him feel good. Those bass tones hit right in the gonads. Not all young men are constantly sexually active, but they are hormonally active. Perhaps they are attracted to this music because it actually settles them down . . . in the same way that rap grew out of the inner city—young black men "chilling out," keeping from exploding from the frustration of watching their brothers and friends die on the streets or end up in jail.

What attracts one kid to death metal and another to Christian rock? For some, identification with a particular musical style indicates resistance to authority and provides an outlet for personal troubles or conflicts with parents or school. For others, music provides relaxation and entertainment, soothes emotions, and creates a groove to dance and clap to. Ultimately, music will not turn a good kid bad. But it can influence a troubled kid and reinforce a negative direction.

Rock is an extraordinary American art form. In any of its varied approximations, rock music is not the problem. If anything, rock, or any other form of music, is an indicator of resonance. We are attracted to that which is

most familiar. If a teenager is drawn to lyrics about suicide or Satan, this is a wake-up call.

The music is the messenger. Don't shoot the messenger! Instead, welcome the opportunity to make genuine, authentic, patient pathways into your children's minds and emotions. Listen to what they are saying by what they are listening to. These are the keys, and they are in your hands.

MUSIC FOR SENIORS

The research that I have come across on music and seniors tends to focus on the use of music for remediation of depression, anxiety, Alzheimer's and Parkinson's diseases, and dementia—in other words, using music for healing. This is valuable information, but in the next section, "Sound Awareness and Seniors," I will address the use of music and sound as enhancement tools for elders who are active and vital in their lives.

Recent Research

"Soothing Sounds: Even Raucous Tunes May Be Relaxing." Research in 1995 indicates that depressed seniors can benefit from listening to music. However, it is recommended that the music selected first match the mood of the listener, then lead to slower and more relaxing pieces as the session continues.[17]

"Recreational Music-Making Modulates the Human Stress Response." This 2005 study by Barry Bittman, M.D., of the Mind-Body Wellness Center in Meadville, Pennsylvania, shows "for the first time" that playing a musical instrument *can reverse multiple components of the human stress response on the genomic level.* Bittman says, "These unique findings not only shed new light on the value of active music participation, but also extend our understanding of individualized human biological stress responses on an unprecedented level."[18]

According to neurologist Oliver Sacks, author of *Awakenings,* "Music can be a crucially important aspect of therapy. Often people who can no longer use or understand language and cannot achieve conceptual thought can respond to music. I've seen patients who couldn't take a single step but could dance, and patients who could not utter a single syllable but could sing."

Music therapist Louise Lynch, director of musical activities at an adult day care center says, "Music is very often the only thing that older demented adults will respond to." Alicia Ann Clare, director of music therapy at the

University of Kansas in Lawrence, states, "Music gives them a window of time to come out of the confusion. Rhythm provides structure and security. It's anxiety reducing." Lynch observes, "The rhythm helps organize them in time and space."

Sacks speaks about the effects of music and rhythm after the sound has stopped. "One of the striking things about music," he says, "is that people not only join in but they often stay organized for a time afterward." According to Sacks, nobody knows quite why music has the effect on Alzheimer's patients that it does. The measure of lucidity may come from music's power to stimulate memories. Memory, he says, is the key to a sense of self.

"We are historical, generational creatures," he notes, "and without memory we lose our identities. Music is one of the most powerful ways of calling out the identity. You have to find the right music, the music that calls the person by evoking certain memories."

In the field of Parkinson's disease, research into the effects of rhythm therapies in improving the ability of patients to walk has been very promising. Some have walked 50 percent faster at the end of studies than when they began. Given that Parkinson's is a degenerative disease, Dr. Michael Thaut, director of these studies, asks, "Can we stem the long-term decline of these Parkinson's patients? That's the burning question." His studies continue.

Sound Awareness and Seniors

The category *seniors,* which by various estimates will soon include the front end of the enormous bubble of baby boomers *and* their parents, is becoming a very large segment of the American population. Therefore, this is the ideal group of people to practice proactive auditory restoration.

Auditory restoration refers to the process of tuning up the auditory mechanism so that it takes in as full a spectrum of sound frequencies as possible. Based on the belief that sound is energy and the ear is a primary portal to the brain and nervous system, the logic is that the more sonic fuel we can take in, the better. What inhibits this flow? The ability to perceive sound through the outer, middle, or inner ear. Other than physiological damage or deformity to the outer ear that would affect the flow of sound, I am essentially speaking about the middle and inner ear.

As I discussed in chapter 6, "A New Awareness of Sound," psychologically induced (stress-induced) hearing dysfunction is a middle-ear issue. Through the process of auditory retraining and sound stimulation, a sub-functioning middle ear can be retuned, its flaccid muscles retonified. This allows

the middle-ear mechanism to transfer a fuller spectrum of sounds to the inner ear. The net effect: enhanced energy, alertness, and increased active listening.

Beyond physical health, a primary concern of seniors is maintaining a sharp and focused mind. Given that inner-ear processing diminishes with age, another concern is being able to hear.

Sound stimulation addresses both these issues. Although inner-ear hearing loss cannot be restored, tonified middle-ear function allows us to use what we've got left more fully.

Where can you partake of sound stimulation and auditory retraining? There is a new generation of soundwork products and practitioners specializing in auditory retraining. Most use derivations of the Tomatis Method. In-clinic and at-home programs are now available.

ThePowerOfSound.com/SeniorsResearch

MUSIC AND EARLY EDUCATION

It seems that barely a week goes by without the appearance of another research study about the effects of music on education. The following headlines say it all: "Music Training May Boost Memory," "Music May Help Neurological Therapy," "Beautiful Music Improves Brain Power," "Musical Links for Scientists and Mathematicians of Tomorrow," and "Improved Maze Learning through Early Music Exposure in Rats."

There is little doubt that legitimate scientific research can verify the power of music. Remaining questions are, *To what degree?* and *How soon?* and *When will music, as an educational aid, be implemented on a mass level?* As research accelerates, there is mounting evidence that music and young children are a very good match.

Recent Research

"New Notes on the Uses of Music." Researchers at Harvard University have apparently seen a correlation between early-childhood music training and "enhanced motor and auditory skills, as well as improvements in verbal ability and non-verbal reasoning," And that correlation, they say, is even more pronounced in children with dyslexia. Gottfried Schlaug, one of the researchers, says the 2009 results "suggest that a music intervention that strengthens the basic auditory music perception skills of children

with dyslexia may also remediate some of their language deficits."

Supporting the findings of Dr. Schlaug, McMaster University (West Hamilton, Ontario) researchers conducted several studies of children to gauge the impact of musical training.[19] In one study, they compared two groups of children: one who were starting music lessons, and one who were doing other activities, like sports. They tested the electrical activity in the children's brains for a year and found that while both groups changed as the children developed, the children taking music lessons changed more in the areas related to attentional processing.[20]

"Music Has Long-Term Effect on Abstract Reasoning Skills." An inner-city day care center was the locale where thirty-three three-year-olds were tested around 1995. Nineteen children were provided with weekly piano lessons and daily group singing sessions. Fourteen children did not receive any musical training at all. After eight months, the musical group showed great improvement in working with puzzles—a standard test for mathematical reasoning skills. In a larger follow-up study, researchers found that children who participated in voice and piano studies increased their spatial-temporal IQs by a 46 percent mean. Those children who received no musical training improved by 6 percent. Spatial IQ is important to higher brain functions employed, for example, when doing mathematics.[21]

ThePowerOfSound.com/EarlyEducation

Online research abstracts include:

- "Early Music Training Alters Brain Anatomy." (1996)
- "Music and Math." (1996)
- "Music Training Boosts Memory." (1998)
- "Improved Maze Learning through Early Music Exposure in Rats." (1995)

Sound Awareness and Early Education

Increased communication between cerebral hemispheres, 46-percent spatial-temporal IQ improvement in three-year-olds, improved math skills in first graders, better word retention by adults who studied music as children, maze-racing rats that accelerate to Mozart Comical? Yes. Serious? Yes. How did Plato know that music is a more potent instrument than any other for education? He probably observed that students who played music excelled in other areas as well. He didn't run clinical trials and get written

up in psychology journals. He simply noted what was in front of him.

What clinicians are finding, in test after test, is that young brains benefit with the simple application of this fun activity. What could be better for education? Yet in the era of budget cutting in public education in America, the arts have been the first thing to go.

What can you do with your children?

1. *Sing with your children.* This is a great way for them to learn a sense of rhythm, practice phonics, make up rhymes, and have fun with you. Locate local music-for-children events. Bookstores often host weekend morning children's musical events.
2. *Introduce them to musical instruments.* Have instruments—even a little drum or tambourine—available for them to play with. My six-year-old daughter pounds on the piano (she can play "Do-Re-Me" from *The Sound of Music*) and sings with a tiny guitar that she cannot functionally play but loves to play with. Fun is the goal at this age.
3. *Buy your child a CD or MP3 player.* There are *wonderful* children's books available online or in record stores (they are orchestrated). Additionally, clever and sweet musical recordings abound, produced specifically for youngsters. It is far better for the development of your children's minds to be listening to music or a musical story than to be sitting in front of a TV. Just as when you read them a story, when children listen to music, their imagination is busy making up a visual story. This practice is lost when they sit passively in front of a TV, with all of the images provided.
4. *Have music playing in your house.* The more your young children hear different kinds of music, the more interest they will focus in that direction. Engage with them about what you are hearing. For instance, you might point out which instrument is playing, then relate this to a visual representation in person or in a picture.
5. *Make instruction available.* If your children show an interest in wanting to learn more about music, inquire about teachers who specialize in nonpressured, gentle instruction. Some children are started in disciplined and rigorous music study at five years old. In this instance, parents are motivated to give their children a head start as professional musicians. There are pros and cons to such early immersion. My suggestion is that early music training should be entered into

only if the child enjoys and gravitates to music. This is a motivation different from creating a child prodigy. Music should never be a forced endeavor; the purpose is to enhance the learning process and to have fun. If it grows into something more serious, this is the child's natural inclination, and you can support it. Forcing a child into music, however, can create lifelong avoidance. A time-tested and lovely introduction to music for children is the Orff Method.

6. *Be a music education activist!* Reprint the information about this research from this book or download research from the Internet (keywords: "music and learning" or "music and education") and bring it to your local school administration. This steady flow of favorable research and a public show of support will help to reinstitute music into the public school curriculum.

Here is an inspiring example of community-based music in education: I was recently staying in a hotel in Phoenix, Arizona. As I sat in the Jacuzzi one quiet afternoon, the pool area was suddenly invaded by two hundred enthusiastic high school students. They were from Hellgate High School in Missoula, Montana, and had just arrived to march in the New Year's parade the following day. As I queried my exuberant hot tub mates, an inspiring story began to unfold.

They came from a school with a student body of thirteen hundred—of whom six hundred were involved in at least one of many music programs, including choir, orchestra, and jazz bands. When I spoke with their highly respected music director, John Combes, I found that Missoula is a city with a long tradition of artists, a community that consistently values the arts in its schools. All children begin choir in grade three. By grade five they can continue with an instrument if they desire. Most of the students in the marching band had begun playing together in the fifth grade and continued throughout their public education. In fact, the fifth-grade music instructor, John Schuberg, works hand in hand with the high school music director, who in turn works closely with the local college music department, which is headed by Schuberg's wife.

I then spoke with a few of the parent chaperons and was told that the band room is where their kids can be found during lunch and after school and that the teaching faculty fully supports the program. If there is a mandatory marching rehearsal at the same time as a wrestling practice, the coach sends the students to the marching rehearsal. This level of community backing is

inspiring and effective. The social context of music here is a healthy umbrella, with all kinds of residual benefits, for these teenagers to grow up under.

MUSIC FOR FOCUS, CONCENTRATION, AND LEARNING

This is an area I have spent a great deal of time investigating. As a writer with dozens of magazine articles under my belt, I am very familiar with the all-night writing sessions required to meet the 10:00 a.m. FedEx pickup deadline. I don't drink coffee or use drugs. Sharp focus starts to lag after midnight. What to do?

I started experimenting with different audio products that claimed increased concentration as a benefit. To my delight, I found a few albums that were extremely effective in helping me hold concentration and maintain productive energy. After I had personally benefited from sound as a productivity enhancer, my vision of the power of music and sound expanded. My investigations into music as a healing art accelerated into an analysis of music for learning and productivity.

Our modern-day use of music to enhance learning is nothing new. In 1970, *Psychic Discoveries Behind the Iron Curtain* devoted a few pages to the work of the Bulgarian psychiatrist Georgi Lozanov. He had developed a process he called Suggestology, a conglomeration of techniques, with music as an integral part, designed to create smarter students. The government of the Soviet Union fully supported his work, thinking that if it could not beat America in the arms race, it would overwhelm us by creating more intelligent people. Lozanov's work came to be widely researched and enthusiastically accepted in the West as the basis for accelerated learning. His work is clearly documented in *Superlearning* and *Superlearning 2000*.

The bottom line of Lozanov's work is the concept *body relaxed–mind alert*. His premise is that there is an ideal psychological and physiological state in which the brain is most receptive to new information. Creating the right level of relaxation in the body and alertness in the mind is the challenge. Music is a key to this.

One of the pleasures of being involved in the unfolding field of psychoacoustics is that both the public and the media already love music. They do not have to be convinced that there are things to be gained from the listening process beyond pure enjoyment. Music is universally adored; that it has meaning beyond entertainment is widely reported and positively received.

In November 1998, at a meeting of the Society for Neuroscience in Los Angeles, multiple clinical studies about music were enthusiastically reported by the press. Studies have revealed direct evidence that music stimulates specific regions of the brain responsible for memory, motor control, timing, and language. For the first time, researchers also have located specific areas of mental activity linked to emotional responses to music. Canadian researchers have discovered that music activates different parts of the brain involved in emotion, depending on whether it is pleasant or dissonant.[22] The brain interprets written musical notes and scores in a special area on the brain's right side. This region corresponds to an area on the opposite side of the brain known to process written words and letters. In studying the brains of expert musicians, researchers uncovered a link between music and language.[23]

In a study of classically trained musicians, researchers discovered that male musicians have significantly larger brains than do men without extensive musical training. Researchers believe that the brain grows in response to musical training the way a muscle responds to exercise. The area of the brain called the cerebellum, which contains about 70 percent of the brain's neurons, was about 5 percent larger in male musicians. The cerebellum grows as a result of the constant practice of the virtuoso motor skills needed to play an instrument. (As an interesting side note, researchers found no such brain increase in female musicians, but said they may not have studied enough women to be certain.)[24]

Repeatedly, studies are showing that music engages the brain at almost every level. Even allowing for cultural differences in musical taste, researchers found evidence of music's power to affect neural activity no matter where they looked in the brain, from primitive regions found in all animals to the more evolved regions thought to be distinctly human. Harmony, melody, and rhythm each initiate distinct patterns of brain activity involving both the right and left sides of the brain. Melody affects both sides equally; harmony and rhythm seem to activate the left side of the brain more strongly than the right.[25]

In 1993, researchers at the University of California, Irvine, found that college students who listened to Mozart's Piano Sonata K. 448 for ten minutes prior to taking a spatial IQ test scored eight points higher than those who did not. The concept is that listening to music might somehow enhance the brain's ability to perform abstract operations immediately thereafter. This phenomenon, known as the Mozart Effect, has received a great deal of media

attention due to the highly publicized, popular book of the same name by Don Campbell (see the bibliography). However, the university research team actually suspects that listening to *any* complex musical piece can produce similar results.[26] It is continuing its study and has found that attempting to replicate it has produced mixed results. The team's report, published in 1998, states that "more work is needed before practical applications can be derived."[27]

The bottom line is that our ability to measure the quantitative impact of music—from Mozart or from any other composer—on the brain is gaining in sophistication. This allows us to specifically understand why we perceive Mozart differently from Beethoven, where in the brain these perceptions take place, and how we can consciously use this information to enhance our lives.

Sound Awareness and Music for Focus and Learning

As clinical studies evolve and rapidly build on one another, they confirm Plato's observation: "Music is a more potent instrument than any other for education." He knew this twenty-three hundred years ago! Unfortunately, while this truth is not disputed, it *is* ignored. Apparently, we are still trying to figure out why music is so potent.

As I've noted, Lozanov believes that in the body relaxed–mind alert state, concentration, memory, and imagination are heightened. To induce this state, Lozanov used mostly the adagio movements from the baroque repertoire. Most of these pieces were sixty beats per minute, corresponding to a relaxed heart rate. In the following few pages, I demonstrate my own thought process as I used Lozanov's concept as well as those of resonance and entrainment to build a sound library that facilitates intensive concentration and clarity of thought. The main question to consider is, *What music will relax my body while stimulating my mind?*

For my writing, I have created a workspace that is as conducive as possible to maximized productivity. It is well lighted and secluded; my phones are turned off; and there is nobody around. Still, a great studio does not guarantee that my brain is working optimally! Thus, I rely on music and sound for energy, focus, and inspiration, but they must not interfere or distract. If they become obtrusive, then soundwork is counterproductive.

I love bossa nova, jazz, and world music, for instance. However, they are not *appropriate for me* when I write. They are great when I am doing other office or creative tasks that do not require intensive focus. In those instances, I am looking for energy, stimulation, and ear candy. The sweetness of this music is similar—*for me*—to a great chocolate chip cookie: it gives me a

rush. Other people prefer sour to sweet. Everybody is different, in food and in choice of sounds.

Here are *my* sound tools for enhanced concentration:

- *Entrainment at work.* The goal is music between fifty and seventy beats per minute. Slower will put you to sleep; faster will make you want to get up and move. (There are times when you will want to do both of these things in the learning process. Pick your times.) Fifty to seventy bpm corresponds to the ideal relaxed heart rate.
- *Resonance at work.* Higher-frequency sounds—those in an upper range, such as high violins, woodwinds, and voices—*charge* the nervous system. An abundance of lower frequencies can *discharge* the system.
- *Gregorian chant.* Dr. Alfred Tomatis alludes to Gregorian chant as the equivalent of two cups of European-strength coffee, and I wholeheartedly agree. High tenor and soprano voices are stimulating (resonance); slow and long vocal phrases slow my breath (entrainment). A perfect sonic alchemy of body relaxed–mind alert. I play chants very softly in the background with my CD player on repeat. I can use this soundscape for hours at a time and not even know it is there. Nonetheless, I really miss it when it is not.
- *Baroque and other classical music.* I find this to be a sticky wicket: some classical music works wonderfully for me, but much does not work at all. Remember, when this music was written, it was not intended as a productivity tool but instead for the church, the royal court, or entertainment. Consequently, all kinds of wonderful musical events take place within a given movement that may not be conducive to concentration. If melody, complexity of harmony, or density of arrangement takes your attention, the music will fail as a productivity tool. Indeed, some believe that classical music cannot be used at all because of its *distraction challenge.* These extraordinary pieces of music were not created to be sonic wallpaper that doesn't disturb. They are living testaments to the continuum of human struggle, emotional landscape, and sacred devotion portrayed by the most gifted composers in the Western world.

So what to do about this challenge?

1. *Find compilations.* Sequenced from classical recording archives, in the best of these compilations, producers have found existing pieces

whose tempos range between fifty and seventy beats per minute and that feature a lot of high-frequency orchestration (high strings). The string section is the dominant force of any symphonic work, but it is not just lots of violins that do the trick. Effective works offer a balance of orchestration among the varied instrument families, melodic and harmonic structures, and tonal ranges.

My personal experience with compilations of prerecorded classical music is a lack of consistency. A case in point: think of a beautifully soft and sweet movement from Mahler. Then, three minutes into the movement, the composer goes harmonically ballistic for no apparent reason. This lasts about a minute and creates a lot of tension, leading to a great release on return to the serenity that I was enjoying. It is a great compositional tactic to keep us from falling asleep, but not effective as a soundwork application. Still, compilation producers will use such a piece because without its one-minute harmonic side trip, it is perfect.

2. *Joshua Leeds's recordings.* I produced multiple albums for the *Sound Health Series* in response to the distraction challenge of classical music soundwork applications. *What is different about these compilations?* Pieces were selected based on specific psychoacoustic criteria. We rearranged the music as necessary to create sound tracks to relax the body, stimulate the mind, and not intrude. The Arcangelos Chamber Ensemble rerecorded these baroque and classical masterworks. Since the first release in 1996, the Sound Health Series has been adopted by school districts, children's learning disability centers, and Tomatis and assorted other clinics throughout North America and Europe. Additionally, parents of children with homework and people faced with the need for clarity and focus in their own work use Sound Health recordings on a regular basis.[28] An additional series, titled *Essential Sound,* was produced by the author in 2003 and 2004. Selections from both the *Sound Health* and *Essential Sound* series (track 13) are available on the companion CD with this book and also online.

We have made it easy for the nervous system to get the benefits of music for learning and focus. Among many psychoacoustic refinements made are consistent pulses in the music, which make entrainment a gentle and effective process. We have also simplified melodic structures where necessary, either by complete omission of a phrase

or by deleting the lead melodic line, allowing the subtle inner harmonic voices to become dominant.

To grasp what I mean, imagine yourself at a live performance of the symphony. You see all the players on stage working away diligently in precise harmony and interaction. However, your brain focuses on the main melody, and the other 75 to 95 percent of the orchestra recedes to the background. The Sound Health Series brings out many of the parts being played by the background players. The extraordinary beauty of the lead lines is generally supported with simplified harmonic structures by these players. For the purposes of the mental immersion sound application, isn't this exactly what you are looking for: simplified sonic support? By occasionally deleting the main melody, we are tapping into the original bedrock of the composition, which has been there all the time, but obscured by the fanciful lead lines and featured instrumentalists.

The enclosed CD, *Music for The Power of Sound,* has many examples of these techniques. The Bach Allegro Assai (track 12) amply shows the process of simplified melodic structures.

3. *Music with light density.* Musical density affects the central nervous system. An easy way of thinking about this is in comparison with a computer. The more information it has to process, the more it needs faster microchips. Do you have a computer with a speed of 300 MHz or a 400 MHz processor? Computing is all about the *amount* of information and the *speed* at which it can be handled. This is no different from the human brain. How much information can your brain absorb quickly?

   Music that features thick arrangements (complex density) requires more processing attention and speed. With this image in mind, consider how you want to spend, or allocate, your brain's processing mechanism. In my own case, for instance, when I am in an intensive mental immersion time, the less complexity, the better. Too much complexity in the music distracts me; it "borrows" some of my attention to analyze the incoming auditory signals. A four-part counterpoint (four separate melody lines tensing and releasing with each other) with full symphonic background requires a lot more processing than does a single or double instrumental line. I also avoid music with lyrics in my native tongue; I don't want to hear other words or thoughts while I am organizing my own.

I use music that is light and spacious: solo acoustic guitar, solo flute, solo piano, duos or trios. These ensembles, by virtue of the small number of instruments, tend to be simpler and thus demand less processing! The sounds still charge the system, entrainment can take place, and the simplicity lends unobtrusive beauty. Nature recordings, too, with or without music, can be lovely. However, be aware that a lot of tacky combinations have come onto the market. I have listed some of my favorites in "Sound Remedies Catalog."

4. *Music or sound with binaural beat frequencies.* Binaural beat frequencies (BBFs) are a means of achieving whole-brain synchronization. This is a good thing when concentrating! If you are not opposed to using a set of comfortable headphones, you will find certain recordings that embed these specific frequencies into their musical tracks to be very effective. (For more information on BBFs, see chapter 15, *Sonic Neurotechnologies.*)

Music in the Classroom

All of the preceding discussion applies to the use of sound in the classroom. If I were a teacher, chalkboard and music system both would be obligatory.

The effectiveness of music in the classroom is well documented. The core concepts of Lozanov and accelerated learning have been wonderfully honed and are worth further exploration if you are a teacher and want to incorporate sound on a rigorous level. Four of my favorite books I recommend are *Soundtracks for Learning: Using Music in the Classroom* by Chris Boyd Brewer, *Rhythms of Learning: Creative Tools for Developing Lifelong Skills* by Chris Brewer and Don Campbell, *The Mozart Effect for Children* by Don Campbell, and *Learn with the Classics* by Ole Andersen, Marcy Marsh, and Dr. Arthur Harvey. (See the bibliography for complete information.)

Recommended reading and musical selections: See "Sound Remedies Catalog."

MUSIC FOR FITNESS AND ATHLETICS

Much attention is paid to the use of music as an adjunct to fitness and athletics. There was no TV network coverage of the first Olympiad, but it would be a safe bet that musicians were there. Where better to use the power punch of entrainment to motivate a stronger workout or training session? Still, note that of the following research excerpts, two speak of dan-

gers inherent in certain commonplace usages of music in the fitness arena.

Recent Research

"Music Holds the Key to Working Out Successfully." The results of this 2009 Brunel University (UK) study reveal that the cardiovascular benefits of training can be boosted by running in time to one's favorite beats. Matching the beat of the music with the tempo of the exercise also regulates movement and reduces the oxygen required during running by up to 6 percent.

Costas Karageorghis, the associate professor of sports psychology who led the twenty-one-year study says, "When you exercise, you go into a state of arousal, at which point the human brain looks for stimuli in your external environment to match. Slow-tempo music of 80 to 110 beats per minute [such as the Beatles' *Let it Be*, which is 80 bpm] would be counterproductive, because your brain wouldn't be able to create a harmony with running fast and the slow beat." The ideal workout tempo is 120 to 150 bpm. In creating a collection of workout music, Karageorghis recommends counting how many times your feet hit the ground during a one-minute run. Afterward, select music with a rhythm that matches it or is a few beats per minute above that number. The researchers have ascertained that training to music lowers one's perception of effort, essentially *tricking the mind* into feeling less fatigued during a workout. Karageorghis believes that there is a science to choosing an effective exercise sound track.[29]

"Feel the Burn, Don't Hear It." In 1998, legislation was filed in Massachusetts requiring health clubs to post warnings about the dangers of exposure to loud music and to provide earplugs if the volume exceeds 90 dB, which is about as loud as a lawn mower. A survey monitoring ninety health clubs nationwide found noise levels in 60 percent of these clubs to exceed 110 dB, or the equivalent of a chain saw. Thirty minutes of ongoing exposure is enough to risk lifelong hearing damage, says the author of the study, an audiologist.[30]

"Headphones and Working Out." Fitness experts say you double your risk of permanent hearing loss when you work out with headphones. The reason for this is that aerobic activities—such as brisk walking and running—force the body to divert blood from the ears and direct it to the legs, arms, and heart. This abnormal blood flow makes the hair cells in the cochlea more vulnerable to loud music.[31]

Online research abstracts include:

- "Wired for a Workout." (1994)
- "Rhythmic Golf Training." (1995)
- "Music Can Help Learn a Sport Faster." (1991)
- "Music and Hormones." (1991)
- "Specific Tempos for Injury Recovery." (1991)

Sound Awareness for Fitness and Athletics

There is a common phrase in the world of sports and fitness training: *use it or lose it*. Given the two most important studies I've seen, the phrase can be adapted to fitness and music: *use it, but don't abuse it!*

Audiologists say that the legislation in Massachusetts has called attention to a widespread, hidden health menace. Combine the effects of music at 110 dB—which after thirty minutes is enough to cause permanent hearing damage—with the new research about how the body diverts blood from the ears to the legs, arms, and heart during brisk walking, running, or working out, and we're talking high impact!

What a terrible dichotomy. We devote valuable time to fitness programs intended to improve health, but in more than half of all aerobic studios, the sound is loud enough to damage our ears. Those of us who prefer a long jog over a country back road with beautiful music in the headphones may be irreversibly damaging our ears.

I used to ski while listening to Steely Dan's rock music or Mozart's allegro movements. It was one of the most exhilarating activities I have ever experienced. I loved it because it helped me to "dance" with the mountain, and I skied better than ever. I had so much adrenaline from the increased rhythmic push that even my last run of the day, with my tired legs, was a nonstopper all the way to the bottom of the mountain. For fifteen minutes, I was youthfully invincible!

Talk to me about the ringing in my ears thirty years later. Yes, it could have been all that loud rock music I played as a teen and in my twenties. Could have been the skiing. It doesn't matter now. The ear does not regenerate damaged cells. Once they're gone, they're gone.

Take this as a word of advice and pass it on to those you love. *Exercise and music are a great pair—quietly.* This may seem like it defeats our purpose; after all, we want the extra push from the sonics. But read the stats. Our ears

and brains are not getting along with the way we have incorporated music into our fitness routines. Aerobics teachers will have to become better motivators and not depend on the latest high-volume hip-hop to keep tired students pushing. Who would have thought that headphones and exercise were an unlikely hazard? But it is, unfortunately, true. This information needs to be common knowledge.

If you choose to use music, be cognizant of its volume. Given current research, headphones are probably not a good idea unless you play the music very softly. If you want the energy or adrenaline bump from entrainment, speakers seem to be a safer bet.

Pick music that falls into the desired beats per minute (bpm) range corresponding to your fitness activity.

TABLE 9.1 PREFERRED BEATS PER MINUTE FOR VARIOUS FITNESS ACTIVITIES[32]

ACTIVITY	PREFERRED BEATS PER MINUTE
Aerobic dance	126–192
Stationary bike—heart patient (50 bpm)	100
Stationary bike—average to high fitness level (80 bpm)	160
Jogging	(10-minute mile) 150
Running	(8-minute mile) 166
Running	(6-minute mile) 180
Rehab. walking (30-minute mile)	90–100
Health walking (20-minute mile)	120
Fitness walking (15-minute mile)	140
Race walking (12-minute mile)	160
Race walking (10-minute mile)	180
Rowing machine (25 strokes per minute)	200

ACTIVITY	PREFERRED BEATS PER MINUTE
Ski simulator	100–140
Stair stepper	80–120
Swimming (crawl, 60 strokes per minute)	120

Note that these numbers are determined by a statistical average. Tempos will vary according to your fitness level and age.

MUSIC IN THE WORKPLACE

Does music enhance the work environment? What happens when the volume of industrial noise is always way up? What about music after work? There are some interesting results from studies beginning in 1973.

Recent Research

"Music via Headphone Boosts Job Performance." In 1995, University of Illinois researchers found in a study of 256 office workers that listening to music of the individual's choice soothed frayed nerves, drowned out distracting office chatter, boosted mood, and significantly enhanced office performance. Also among the positive effects: greater satisfaction with the employer and reduced interest in switching jobs.

Job performance in simple clerical work was increased by 14 percent; in more complex jobs, by 7 percent. Those who didn't do well wearing headphones were people who had to talk on the phone a great deal and those with more complex jobs that required greater attention.[33]

"Hearing Protection Device Use among Industrial Workers." 1996 research in North America has shown that the percentage of workers exposed daily to harmful noise (over 85 db) varies between 30 and 60 percent across industries. In certain industries, it may reach as much as 95 percent. Yet the percentage of workers who take measures to protect their hearing is surprisingly low, despite regulations requiring their use.

With noise exposure—as with chronic exposure to other environmental hazards—the negative health outcome is gradual; the timing of possible damage is uncertain; and no visible, immediate damage is apparent from any one exposure. *Hearing loss becomes manifest only after several years of*

noise exposure. In the short run, then, no one is able to perceive either the benefits of using hearing protection devices or the damage incurred from non-use.[34]

"Heart and Blood Disease Greater in Noisy Industries." A study dating back to 1973 indicates a greater prevalence of cardiac and peripheral vascular disease and hypoglycemia in workers in very noisy industries than in those employed in less noisy industries.[35]

"Using Music to Forget a Hard Day's Work." For some executives, making music is just about as sweet as making money. Be it opera or rock, cabaret or country, music represents for them the ultimate escape from the rigors of corporate life. For some it is the realization of a lifelong aspiration, even as they make their careers in the very different world of business. According to a 1993 *New York Times* article, "Lawyers, CEOs, psychologists, and stockbrokers use their previous musical training as an adjunct to their professional careers for stress reduction and personal revitalization and creativity."[36]

"A Musical Interlude from Stress." Neurologist Barry Bittman, head of the Mind-Body Wellness Center in Meadville, Pennsylvania, says the fact workers are seeking solace in making music is not surprising. His 2009 research shows that creative musical expression can boost the body's ability to fight cancer and is three times more effective than passive relaxation in reversing the impacts of stress on the body at the molecular level.[37]

Rules of Thumb

- If you are in an office, use music wisely. It can be of great assistance.
- If your workplace features loud industrial noise, use ear protection.
- You will not know that you have lost your hearing until it is irretrievably gone.

Sound Awareness for Music in the Workplace

Music and the office are a natural match. The challenge is personal preference and control. If you can have your own sound system, either with headphones or without, you have the best opportunity to use music and sound to enhance your work life. If you work at a computer with a CD-ROM drive, you can play any regular CD and hear it directly through the computer (if it is equipped with speakers) or through headphones plugged into your computer.

Sound and rhythm create mental and emotional environments. What is most conducive to your task? Do you need help concentrating or simply

staying awake? Do you want to be energized or sedated? Is there a big meeting coming up? Are you uptight about a presentation you have to give? The intentional use of music in the office is a perfect soundwork application.

- *For enhanced concentration and mental immersion*, revisit "Music for Focus, Concentration, and Learning" (page 110) to refresh yourself on all the information you need to use music to increase concentration. If your office work is conducive to uninterrupted headphone usage, take advantage of the binaural beat frequency selections I've listed in "Sound Remedies Catalog." And classical or other music in the range of fifty to seventy beats per minute will be your best bet.
- *Staying awake, increased energy.* This is the best time for uptempo, fun music. Pull out the jazz, country, reggae, pop, or classical allegro movements. Turn up the volume a bit. Be considerate of those around you; they may not need the sonic hit you are looking for. If you wear headphones, remember that high volumes close to the brain might give you two things: the energy endorphin rush you are looking for and dead auditory brain cells.
- *Music in industrial settings.* If there is ongoing noise in your workplace, be careful. Rather than using music turned up higher than the noise, you will be auditorily better off if you wear earplugs. You want to guard your delicate and precious hearing mechanism. Replacing one sound with another, louder sound may bring you temporary psychological relief, but it will also cause hearing damage.

Headphones

Headphones come in many varieties and prices. Earbuds—small, comfortable transducers that fit right into the ear canal—allow you to listen at *very low levels* and do not block out external noise. They also do not require over-the-head binding; their small wires follow your jawline, proceeding from under your chin to the connector on your sound system. (Because they lack headgear, earbuds are good for bedtime listening.) You can listen to your sound tracks and be in a conversation with an associate at the same time. The opposite of this is the closed-ear system, whereby the entire ear is covered by the headphone. This will block out external noise to a degree determined by the quality of the headphone. (Author's note: See p. 80 for elaboration of headphones and MP3 players.)

Earbuds can be purchased for as little as $10. Closed-ear headphones range anywhere from $25 to $250. As a point of reference: my professional closed-ear headphones, used in studio mixing and mastering, cost $150. For normal use, a good closed-ear set shouldn't cost more than $60.

In the long run, however, a set of $100 headphones will be much better for your ears than a less expensive model. With higher-quality headphones, you do not need to turn up the volume to achieve a full spectrum of sound. You can listen quite quietly. With cheaper headphones, you need higher amplitude to achieve a full bass and treble response. Consequently, you often listen at a volume not conducive to auditory health.

Finally, I recently spoke with an office manager who is an avid headphone user. She was concerned that, when she used headphones in areas of high ambient noise levels, she had to turn up the volume higher than was probably best in order to hear. She wanted to know what to do.

If your ears are ringing when you take off your headphones, you are listening at too high a volume and may be causing hearing damage. A rule of thumb is that if you can't hear someone talking to you while you listen, the volume is too high. Also, be aware of listening with headphones for too long. Your ears may habituate to the sound, and your inclination will be to turn up the volume, especially if you are trying to shut out surrounding noise. After an hour, let your ears rest for fifteen minutes or more. Headphones are a major source of noise-induced hearing loss. Be very careful with them.

An emerging field of study centers on the masking of sound, referred to as noise cancellation. The concept is that by finding sounds of equal frequency, you can essentially create a sonic block, or neutralization, of the offending noise. This has to do with different methods of phase and interference with the offending sound waves. If you have a particular noise problem and an employer willing to look into what can bring relief, I encourage you to take advantage of the Internet using the keywords "noise cancellation."

Remember also that if the attractor for disease is compromised immune function, sound pollution contributes greatly. Interestingly enough, long-standing bad odors, bright lights, and continuous bad tastes are not tolerated. Sound seems to be the only sensory input that we are surrounded with but have little control over. Bear this in mind as you enthusiastically bring music into your workplace. Everyone brings his or her own lunch to meet his or her own dietary requirements; use sound in a similar fashion. Think: nutrient sound.

MUSIC IN THE HOME

Recent Research

"The Housing Environment and Women's Health." This 1978 Canadian study examined three indicators of the quality of the home environment affecting the mental and physical health of married women with children: perceived space and privacy problems; structural deficiencies in the dwelling; and the nonstructural deficiencies of noise, cold, and pests. The good news in this study was that while noise, cold, and pests "adversely influence health, they are not a major cause of poor health." Although researchers have been concerned about the medical consequence of excessive noise, their conclusion was that the "trauma of noise may bring to the surface a scarcely submerged tension and result in an emotional outburst."[38]

In other words, noise, cold, and rats are not as lethal as dioxin or asbestos. This is reassuring!

"Human Response to Environmental Noise." It is estimated that noise levels in the United States increased more than 11 percent between 1986 and 1996. It is predicted that these levels will continue to grow at least as rapidly as the general population and that noise from air traffic will increase at an even more rapid rate.

Prolonged exposure to environmental noise has been related to impaired scholastic performance and learning ability, higher blood pressure, and lowered tolerance of frustration. Researchers have identified nonauditory health effects of noise as indirect, cumulative, and stress related. They caution that studies of noise's effects on nonauditory function are inconclusive at this point.

There is, however, a growing body of research indicating that noise effects are psychologically mediated. It has been noted that individual differences in response to noise are striking. On average, more than 50 percent of variations in reactions to noise can be accounted for by psychological factors. Several investigations suggest that physiological effects and health complaints are more closely related to subjective reactions to noise than to noise itself.

Adverse reactions to noise arise predominantly from two factors: the perceived inability to control your exposure and the appraisal of an event as threatening important personal needs or goals. The appraisal of noise as a noxious quality of the environment, while often subjectively based, may still trigger stress-related effects. These can include blood pressure

increases, increased catecholamine secretion, and inhibited immune system functioning.

Researchers add, "A person's home is a different context for evaluating control over noise than it is for evaluating control over other ambient stressors such as air pollution. The home can be an escape from exposure to air pollutants. In contrast, noise impacts that penetrate the interior of the home represent an inescapable violation of the safety presumed of a primary setting."

The study concludes with the following: "Noise may not be etiologically related to any given disease but may enhance susceptibility to disease in general and, thus, may cause a wide variety of physiological and psychiatric symptoms."[39]

Sound Awareness and the Home

We know that uncontrolled amplitudes of extremely low or high frequencies can cause physiological reactions. From the research just discussed, we understand that under normal circumstances, there is no such thing as "noise disease" per se. However, stress, which is a psychological perception, is known to weaken the immune system. If noise causes stress, weakened health may be an indirect consequence. It is an interesting note that the penetration of noise into the home represents an "inescapable violation of safety." This statement points to the auditory dilemma of the day: the control of our auditory environment.

From research, we understand that some people are more sound sensitive than others. This can originate either from auditory damage whereby we can no longer block or filter out extraneous sound very well or from an inherited and normal sound sensitivity. Either way, our homes are our last bastion of sonic defense—the place where it is hoped that we have some control over the environment. This control is the opposite of what we experience when we are out and about in town.

I used to live in New York City, and there is no better place to test the adaptability of the auditory function. I never knew what sounds—sirens, screeching car tires, a cappella singing, foreign language bantering, crying babies, laughing friends, boom boxes galore—I would encounter and therefore process next. A sound feast! Remember, the initial purpose of hearing is survival. In New York, your ears have quite a workout. Our homes are the place of release where we choose what sounds, or silence, we will enjoy or tolerate.

In your abode, why put yourself in a position where you must *tolerate* the soundscape? If you share the space with others, inform them of the effect of sound and the importance of having a place of sonic control. The sound environment of where I live is the most important thing about it to me—more important than the visual.

Not everyone is auditorily aware. Therefore, politely set your sonic boundaries with relatives and roommates. Determine your needs for music and silence and politely make your arrangements. Remember, everyone has different requirements. Don't be a sonic dictator, but don't be a sound victim either.

MUSIC IN THE CAR

I have found no research on this topic, but common sense goes a long way. Two levels of awareness can be addressed with music: staying alert and staying calm. There is a big difference between music used on a long, unobstructed highway journey and music used in rush-hour traffic.

Highway Driving

When we are traveling long distances, the role of music is to keep us alert. Long journeys mean we are behind the wheel for extended, often monotonous periods of time. Putting entrainment to work, this is the time to use uptempo music. Pick out your favorite jazz, rock 'n' roll, or big-band selections. Alternate these with classical music. The goal is to keep your brain from habituating, so keep the music and the tempos varied. Entertainment also helps keep the mind active. Books-on-tape and instructional audio programs are thus excellent for long drives.

Rush-Hour and City Driving

"Road rage" reflects the level of stress felt when maneuvering in too small a space with too many cars. This is the time to use music that will keep you both alert and relaxed. Whereas faster tempos are recommended for road trips, in the city, where patience is a necessity, midtempos (sixty to ninety beats per minute) are suggested. As with enhanced learning, where body relaxed–mind alert is the preferred state, city driving demands a similar state. Classical music (adagio alternating with allegro movements) and light jazz both have medium tempos and often feature high-frequency instruments. As you know, the higher-frequency sounds tend to energize the nervous system.

This aids in maintaining alertness. Consequently, music with high strings, flutes, and saxophones is a good choice. As always, it comes down to taste. By applying the principles of resonance and entrainment, you can determine which music is uplifting to the neurological system and which actually has the opposite effect. Talk radio is also good for maintaining alertness because it is keeping the mind engaged. Still, the goal is to stay calm and cool, and music can have a big influence on this.

MUSIC AND THE HEART

Dr. Luciano Bernardi, associate professor at the Department of Internal Medicine, University of Pavia, Italy, believes music is a powerful tool in the management of cardiovascular disease. In an article featuring Bernardi in *Circulation: Journal of the American Heart Association,* medical writer Emma Baines reports:

> *The idea that music has an effect on heart rate and blood pressure has existed for some time. In 1918, Hyde and Scalapino*[40] reported that minor tones increased pulse rate and lowered blood pressure, whereas "stirring" music increased both blood pressure and heart rate. Dr Bernardi became interested in the effects of music on the heart as a result of his research on the ways that he could influence the rhythms of the autonomic nervous system to improve respiratory and cardiovascular function.

In research involving music and heart function, Bernardi has been quite active. The following excerpts, from studies conducted between 2001 and 2008, focus on the valuable work he is doing.

"Dynamic Interactions between Musical, Cardiovascular, and Cerebral Rhythms in Humans." Per Bernardi, previous studies have suggested that cardiorespiratory variables (heart rate, respiration, blood pressures, middle cerebral artery flow velocity, and skin vasomotion) increase with faster tempo *independent of individual preference.* In 2008, the Bernardi team tested whether compositions characterized by variable emphasis beside rhythm (vocals, orchestral arrangements, progressive crescendos, more uniform emphasis, rhythmic phrases, or silence) could produce parallel and instantaneous cardiovascular/respiratory responses. In the study of twenty-four healthy subjects, conducted by the Department of Internal Medicine at

University of Pavia, vocal and orchestral crescendos produced significant correlations between cardiovascular or respiratory signals and the music profiles. Of note, skin vasoconstriction and blood pressures were proportional to crescendo. This was in contrast to a uniform musical emphasis, which induced skin vasodilation and reduction in blood pressure.

The researchers' conclusion was that music emphasis and rhythmic phrases *are tracked consistently* by physiological variables. Autonomic responses are synchronized with music.[41]

"Cardiovascular, Cerebrovascular, and Respiratory Changes Induced by Different Types of Music in Musicians and Non-Musicians: The Importance of Silence." The objective of this 2005 study was to assess the potential clinical usage of music for the modulation of stress. Could changes in the cardiovascular and respiratory systems be induced by music? Tempo, rhythm, melodic structure, pause, individual preference, habituation, sequencing, and previous musical training were considered. Twelve musicians and twelve age-matched controls were presented, in random order, six different music styles (first for a two-minute, then for a four-minute track), with a randomly inserted two-minute pause, in either sequence. Results showed ventilation, blood pressure, and heart rate *increased* and midcerebral artery flow velocity and baroreflex *decreased* with faster tempi. The simpler rhythmic structures compared with baseline, and no habituation effect was seen.

What stands out in this study is that the pause reduced heart rate, blood pressure, and minute ventilation, even below baseline. An "order effect" was evident for midcerebral artery flow velocity, indicating a progressive reduction with exposure to music, independent of style. To no surprise, musicians had greater respiratory sensitivity to the music tempo than did nonmusicians.

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From this research we can conclude that music induces an arousal effect, predominantly related to the tempo. Slow or meditative music can induce a relaxing effect; *relaxation is particularly evident during a pause.* Music, especially in trained subjects, *may first concentrate attention during faster rhythms,* then induce relaxation during pauses or slower rhythms.[42]

"Effect of Rosary Prayer and Yoga Mantras on Autonomic Cardiovascular Rhythms: Comparative Study"

In 2001, twenty-three healthy adults were tested to see whether rhythmic formulas such as the rosary and yoga mantras could synchronize and reinforce inherent cardiovascular rhythms and modify baroreflex sensitivity. (The baroreflex is responsible for maintaining a stable blood pressure despite changes in body positions, and it fails in many autonomic disorders.) The Ave Maria (in Latin) or a mantra were recited, with spontaneous or metronome controlled breathing, on breathing rate with rate and regularity of breathing, baroreflex sensitivity, and frequency of cardiovascular oscillations measured.

Dr. Bernardi's team found that both prayer and mantra "caused striking, powerful, and synchronous increases in existing cardiovascular rhythms when recited six times a minute. Baroreflex sensitivity also increased significantly." Their conclusion: "Rhythm formulas that involve breathing at six breaths per minute induce favorable psychological and possibly physiological effects."

Prior research had shown:

- reduced heart rate variability and baroreflex sensitivity are predictors of declining heart disease, and
- slow breathing enhances heart rate variability and baroreflex sensitivity by synchronizing inherent cardiovascular rhythms.

Adding to the progression of understanding about the effect of self-induced rhythm on the nervous system, this study suggests that in the recitation of the rosary and also of yoga mantras, respiration slowed to almost exactly 6 breaths per minute, which enhances heart rate variability and baroreflex sensitivity. The researchers suggest that the rosary, beyond a religious practice, might be also viewed as a health practice.[43]

ThePowerOfSound.com/HeartResearch includes the following:

- Soothing music can increase oxytocin levels during bed rest after open-heart surgery: a randomized control trial. (2009)
- Music for stress and anxiety reduction in coronary heart disease patients. (2009)
- Music listening enhances cognitive recovery and mood after middle cerebral artery stroke. (2008)

What Happens When the Music Stops? A Consideration of Silence.

Speculation, conversation, and research takes place inside and outside of medical circles about the role of music on the nervous system. In 1918, the *American Journal of Physiology* ran an article discussing the role of minor tones in relationship to heart rate. Shortly thereafter, others discussed how respiratory rhythms were locked in with the listener's ear. Between 1986 and 2003, many researchers agreed that biological oscillators are entrained by external inputs, including feedback from muscles during exercise, somatic afferent nerve stimulation, auditory inputs, and vestibular stimulation. In 2005, the conversation turned to the role of silence and how the tempo may be more impacting than the melody, style, or listener's preference.

In *The Sound of Silence is Music to the Heart*, two New Zealand-based doctors (specializing in anesthesia and resuscitation) pose this interesting hypothesis:

WHAT HAPPENS WHEN THE MUSIC STOPS?

Perhaps the most interesting observation in the study by Bernardi and colleagues is not their description of the effects of music on respiratory and cardiovascular function, but rather the consequences of turning the music off. They randomly interspersed a two-minute period of silence between the different styles of music they studied, and found that respiratory frequency, heart rate, and blood pressure all decreased to below baseline levels. The authors suggest that the music is associated with a level of arousal, and that relaxation occurs when the music is stopped.

An alternative explanation for the observed decrease during silence is that the entrainment or forcing of the respiratory and sympathetic oscillators by the auditory input resulted in both respiratory frequency and sympathetic outflow being elevated. While the driving input was present, what was observed was the consequence not of the intrinsic state of the oscillators, but rather a product of the intrinsic state combined with a driving input. A consequence of driving the oscillators at increased frequencies may well be a decrease in the intrinsic frequency, and this decrease is what is observed in the period of silence when the music is stopped.[44]

Put another way . . . does the actual entrainment response itself, regardless of faster or slower external stimuli, cause an arousal of the body's primary pulse systems? While the underlying tempo of different types of music may have an effect on heart rate and blood pressure, when considering the *entrainment* response, perhaps we must recognize that the mere act of entrainment has an effect all unto itself that must be balanced with the arousing or soothing effect of an external rhythm.

SOUND AWARENESS AND THE HOSPITAL

"Hospital Noise—Level and Potential Health Hazards." Except for noise-induced hearing loss, there is no known noise-induced disease. However, human beings can react to noise psychologically with fear, annoyance, anger, agitation, or pleasure, and any of these reactions can then alter the physiological state.

In addition, noise produces recognized physiological changes in the endocrine, cardiovascular, and auditory systems, as well as affecting sleep. A well-established effect of noise on the human cardiovascular system is vasoconstriction. Most of these changes do not cease on repeated exposure to noise.

Simply put: just because we are exposed to lots of irritating noises doesn't mean our systems adapt to them. We don't get used to them, if they irritate, they just keep on irritating!

If these physiological changes become extreme, noise becomes a health hazard. Researchers have found that noise levels in incubators, recovery rooms, and acute-care units are of sufficient intensity to interfere with sleep and possibly to damage hearing in patients receiving certain antibiotics. The pituitary-adrenal axis has an extremely low threshold for stimulation by noise—as low as 68 db. The average noise levels in the recovery room, acute-care unit, and incubator exceed this intensity.[45]

Here are some of the conclusions we can draw from the research on hospitals and noise:

For surgery. Surgeons are likely to do a better job at the operating table with background music. If the music is of their preference, it is all the more effective. Therefore, in a pre-op conference, find out what kind of

music your doctor likes. If it corresponds with your personal taste, you've got a good match. If it doesn't, decide who needs the music more—you or the surgeon. I suggest you put yourself first in this department and let the surgeons worry about their own stress. That's their job. Your job is to absorb the positive effects of your surgery and heal as quickly as you can.

Music will accomplish the same thing, in different degrees, for you and your operating team. It reduces the stress hormones and keeps everybody relaxed. The surgical team will operate more efficiently; you will recover and heal more quickly.

One of the many facets of surgery is the use of anesthesia. You need this pharmaceutical intervention for pain reduction and numbing purposes. Anesthesia is a good thing; it is also better to have less than more. The sooner your physical system can resume full custody of your bodily functions, the better it is for your recovery. Music can help you do this. Whether you are awake or asleep during surgery, you will benefit from music being played.

What music does is blunt the stress hormones, including norepinephrine, epinephrine, and growth hormones.[46] When these hormones increase, blood pressure and bleeding during surgery also increase. To keep stress and blood pressure down, more anesthesia is used. The more anesthesia, the longer the period of time when your body is not fully producing natural healing agents, which increases the possibility of complications. Better to use the music of your preference to stay relaxed during surgery and reduce the amount of anesthesia. The music's effects will continue in the recovery room, even after it stops playing. Music will also help you recover and get you home faster.

For extended hospital stays. A hospital is an institutional setting designed to facilitate various activities and situations. Unfortunately, a hospital's sonic environmental design—that is, its noise level—is not the most beneficial for rest and recovery. Patient satisfaction studies have shown that environmental factors can significantly affect clinical results.[47]

Within an institutional setting, how can you create a sonic environment conducive to healing and recovery for yourself or for those you love? Interrupted sleep patterns, hospital employee noise, procedures for other patients, and the incessant sounds of commercial TV do not lend themselves to ideal sonic healing space. The noise and distractions are often an impediment to efficient recovery. Yet the hospital must function, and noise is a part of everyday activity.

The answer to this is actually simple: earplugs, headphones with a portable cassette or CD player, and appropriate recordings. There are several goals:

- To create as much of a chance for uninterrupted sleep as possible
- To establish relaxation and reduce anxiety
- To provide positive entertainment
- To use sonic tools for self-directed healing (meditation and self-hypnosis, for example)

By establishing auditory insulation from the institutional setting, you lay the groundwork for faster recovery. What you are essentially doing is applying the principles of sound awareness. If you cannot control the environment around you, control it within your ears. This can be done.

Earplugs are a wonderful way to mask noise. They come in all shapes, sizes, and prices. When you want to sleep, meditate, or tune out of the environment, use the plugs; they are the equivalent of eyelids, and they can help give you a sense of control over your personal environment, even in a situation that may feel overwhelmingly out of control. Take back your personal sound space. Establish auditory boundaries.

Headphones are an integral part of auditory boundaries, too. Use earplugs when you want quiet; use headphones when you want auditory stimulation or sedation. The more you can use sound, the less you are dependent on medication.

Sound Equipment in the Hospital

Your body is in flux when you are hospitalized. You are likely to be under the influence of pharmaceutical drugs that may have side effects. For example, certain antibiotics can create a lower threshold for noise stimulation—as low as 68 db. Therefore, a simple rule of thumb about headphone usage is to *keep the volume low.* You do not need loud sound to mask existing noise levels. (If your roommates play the TV too loud, politely ask them or a nurse to turn it down or to use a headphone system themselves.) Just as we instinctively recognize the need for personal space in the physical realm, hold on to the image of auditory boundaries. This is a state of mind assisted by the earplugs and headphones. Volume is not the factor for establishing your own sound zone, though.

Headphones, like earplugs, also come in all shapes and sizes.

You will also need a portable CD or MP3 player, which can easily be plugged into the wall. This way you don't have to worry about battery replacement. Portable CD players run $50 and up. Those in the $100 range are usually more reliable. And iPods can be found beginning at $60.

For a total of $100 to $200, you can purchase a sound system: earplugs, headphones, and portable sound music player. This is a very small price to pay for a great deal of comfort. Many hospitals have portable equipment and a tape or CD library. Request this, or ask for a visit from a hospital music therapist, who can directly assist you in this process.

Sound library for the hospital stay. In the hospital you want music and sound recordings that help you sleep, keep you relaxed, distract or entertain you, and assist in self-directed healing. The most important thing to remember is that sonic space is your private space. *Listen to whatever helps you feel better.* If you like big-band music, use it! Opera, country, zydeco? It is your choice, and no one even knows what you are listening to. This is a completely private zone. Do what you like!

Over the last twenty years, numerous series of recordings have been created by notable medical and psychological authorities for self-directed healing. They contain many psychoacoustic techniques to assist that process. Music and guided imagery make a great mix: research has shown that their combination reduces specific stress-producing hormones, including plasma B-endorphin and ACTH.[48]

Other recordings contain specific psychoacoustic techniques with a strong emphasis on resonance and entrainment. In some cases, binaural beat frequencies are employed (see chapter 15). I recommend this technology in a hospital setting; it may amplify the effectiveness of sound tracks. If you have any kind of a condition that may contraindicate the use of this psychoacoustic application, especially anything having to do with seizures, consult your doctor first.

ThePowerOfSound/HospitalSoundResearch

- "The Influence of Musical Rhythm in the Perception of Time and Emotions of Adult Patients Undergoing Hemodialysis." (2008)
- "Music to Operate By." (1994)
- "A Musician Who Performs with a Scalpel." (2007)
- "Relaxation Therapy Works." (1991)
- "Music and Pattern Change in Chronic Pain." (1993)

See "Sound Remedies Catalog" (p. 271) to get started or to trigger your imagination. As you will see, almost all of the recordings listed there were created specifically for therapeutic applications.

In the next chapter, *Progressive Sound Health for the Hospital Environment,* we explore leading-edge European and American companies that are pioneering hospital *soundspace* with rigorously considered sound tracks and delivery systems for healing environments.

CHAPTER 10

Progressive Sound Health for the Hospital Environment

Between 2001 and 2010, there has been much musical activity directed toward hospital environments, including nursing homes, hospices, and various medical centers. In this section, we will look at recent efforts to provide live and prerecorded music into health care centers.

LIVE MUSIC IN HOSPITALS: MUSIC THERAPY AND THERAPEUTIC BEDSIDE MUSICIANS

In scoping the hospital soundscape, we must acknowledge the wonderful live music provided by music therapists and therapeutic bedside musicians. More and more, their gentle harps, guitars, tambourines, and other portable instruments fill the halls in often austere settings.

There is a big difference between *music therapy* and *music healing*, just as there is an important distinction between *music* and *sound* healing. Since the 1950s, board-certified music therapists have worked in many settings, including hospitals. At the heart of music therapy is the interaction between credentialed therapist and patient, and of course, their interaction with music! *The music therapist engages the patient in an experience of music using live and recorded material to promote relaxation, pain management, expression of emotion, and other therapeutic goals.*

Many U.S. universities offer either a music or counseling degree with an emphasis on music therapy training. And over the years, numerous specialized branches of music therapy have developed. There are more than five thousand active music therapists in America. In-depth information can be found through the American Music Therapy Association (www.musictherapy.org).

A practitioner of a newer form of music healing employed in homes, hospices, and clinical settings is now known as a *therapeutic musician,* playing live music at the bedside of people who are faced with physical, emotional, and spiritual challenges. The credentialing process and scope of practice for therapeutic musicians is distinctly different from music therapists.[1]

The Music for Healing and Transitions Program (MHTP) is one of a growing number of training programs currently available for therapeutic bedside musicians. I asked MHTP's executive director, Melinda Gardiner, to explain a therapeutic musician's scope of practice.

"A therapeutic musician is a musician, not a therapist. We are specifically trained to be centered upon, and open and receptive to the patient's physical, emotional and/or spiritual needs that may be supported with live therapeutic music. Therapeutic Musicians use the art of live music (and thus the science of sound) to meet the immediate needs of the patient, and to create an environment that fosters healing. We bring beauty into the health care environment."

Therapeutic bedside musicians have been coming into American hospitals largely through the efforts of the following training programs:

- Chalice of Repose Project[2]
- International Harp Therapy Program (IHTP)[3]
- Music for Healing and Transitions Program (MHTP)[4]

Therese Schroeder-Sheker is highly revered for her work in pioneering the field of modern bedside music. Her Chalice of Repose Project laid the groundwork that enabled Laurie Riley and Christina Tourin to start MHTP and IHTP, respectively.

More recently, online courses, created by innovators in the bedside musician pedagogy include:

- Clinical Musicians Home Study (www.harpforhealing.com)
- International Healing Musician Program (www.healingmusician.com)

As the programs have grown deeper roots, graduates in the field as of 2010

are estimated at eight hundred to one thousand. Many of the programs work with the National Standards Board for Therapeutic Musicians (NSBTM) to develop and maintain standards for therapeutic musician training programs and their graduates.[5]

DIFFERENTIATED ASPECTS OF MUSIC THERAPY/MUSIC AND SOUND HEALING

In closing this section, I wish to share the remarks of Barbara Crowe,[6] author, music therapy professor, and former president of the National Music Therapy Association, whom I queried about the distinctions she sees in the overlapping fields of music *therapy* and music and sound *healing*. These are subtle but important differentiated aspects of a field continuing to evolve.

"To me," Crowe said, "here's the crux of the difference between *music therapy* and other forms of *music healing:*

- "*Music therapy* is where the *experience* of the music, including the relationship with the music therapist, is the vehicle for needed change. There are numerous approaches under the umbrella of music therapy utilizing many therapeutic models, including psychotherapy, behaviorism, neurological intervention, and community performance of music called *musicking*.
- "*Music healing* is when musical elements presented in a music form are employed as an external object to impact the client's health/functioning. Therapeutic bedside programs are forms of music healing since they emphasize the characteristics of the chosen music as the elements that positively impact the client's health.
- "Also related but somewhat different is *sound healing*, which uses isolated sound characteristics for physical/energetic benefit. Vibrotactile experiences are another category of sound healing. An example is SaraJane Williams' Vibroacoustic Harp Therapy work." (See page 203.)

NEW SOUNDS FOR HOSPITALS

The remainder of this chapter focuses on therapeutically oriented systems that use prerecorded music. Between 2001 and 2010, three varying endeavors in Europe and the United States have launched, all with the purpose of bringing therapeutically designed recordings into hospital-like settings. This

catches my attention because of the scope of the initiative: *providing the right music for the right purpose at the right time.* This goal requires long vision, much patience, and financial fortitude. However, the rewards will be great for the companies that find their ways into the private and public health venues. Following is a discussion of a few notable pioneers who are also laying groundwork for intentional musicians to come.

Sanoson (Austria)

> *"A patient comes in suffering from depression. The first step is always to see the physician. But then there will be the choice of treatment options: the shrink, Prozac or music."*
>
> VERA BRANDES

Vera Brandes is the director of the research program in music and medicine at the Paracelsus Private Medical University in Salzburg, Austria. She is also head of research and product development at Sanoson, an enterprise based in Vienna.

Sanoson applies the latest scientific findings from chronobiology (which, as we discussed earlier in this book, is a field of science that examines cyclic phenomena in living organisms)[7] and research into the therapeutic effects of using music. The organization develops music-based treatment programs and custom music systems for use by medical doctors, rehabilitation centers, clinics, hospitals, and other treatment facilities.

"I am the first musical pharmacologist," she claims. Brandes is developing medication in the form of music, dispensed as a prescription. "We are preparing for the launch of our therapies in Germany and Austria in the fall of 2009 and are anticipating the U.S. launch in 2010."[8]

The 2009 book *Music that works*[9] (which, as discussed earlier in this book, comprises a selection of presentations from the 2006 Mozart & Science Conference), Brandes contributes a chapter titled "*Music as a Medicine: Incorporating Scalable Music-Based Interventions into Standard Medical Practice.*"[10] For the development of standardized methods for the application of receptive music therapy in psychosomatic medicine, Brandes stresses that a multitude of factors contributing to the effects of music on individuals need to be considered. Therefore, interdisciplinary research teams composed of health psychologists, psychophysiologists, chronobiologists, physicists, mathematicians, physicians, and research experts in psychological morphology have contributed to the scientific foundation of her methods. One of the

methods Brandes and her colleagues developed is based on newly composed therapeutic music programs and listening schemes[11] developed to ameliorate the symptoms of depression and burnout[12] Once a participating doctor establishes a diagnosis, the patient is sent home with a specially developed listening device filled with highly specific sound tracks, with a strong focus on circadian rhythms. Brandes says, "Calming music heard at an ascending point in your circadian cycle wouldn't calm you. It may even annoy you. In our research," she continues, "we have found that when people are listening to music they know, their reactions are entirely different." To that end, only original music and nature sound tracks are used. Special headsets are also included.[13]

Additional information on Sanoson and Vera Brandes:

ThePowerOfSound.com/HospitalSounds

Harmonic HealthCare (United States)

Don G. Campbell is no stranger to big projects. In addition to authoring twenty-three books, including *The Mozart Effect* and *Healing at the Speed of Sound,* and producing twelve benefit-specific audio programs, he's advised schools, teachers, and corporations for thirty years on the importance of creating the proper aural environment for healing and learning. When I heard that he had consented to provide musical and acoustic services for Aesthetic Audio Systems, I knew he had met his match. His job was to select appropriate music for hospitals—wall-to-wall sound for each public space based on the needs of patients, visitors and staff. Not just for one day, but 24/7 for 365. I knew somebody had to finally take on this task, and I was so glad it was he and not I!

Aesthetics Inc. is a multidisciplinary design firm that has created multisensory healing environments for health care institutions for over twenty-five years. When they launched Harmonic HealthCare auditory environments in twenty hospitals and medical offices, the goal was to provide music in health care public spaces to enhance and reinforce the healing experience for patients, visitors, caregivers, and staff.

Specially designed compilations of ambient, jazz, and classical music are now available to hospitals, clinics, medical offices, and assisted-living communities. Custom-designed audio systems address the specific needs of each zone in the facility. Not only is the music intended to reduce stress and anxiety, invigorate and refresh the minds of patients, visitors, caregivers, and

staff, and enhance the healing experience, but these sound tracks also are designed to emphasize the institution's focus on compassion and caring.

According to the Aesthetic Audio Systems website, every applicant facility is evaluated to determine:

- Unique architecture, geographic location, and culture.
- Existing auditory and acoustic environment of every room (lobby, emergency waiting area, chapel, administrative offices, etc.) and outside space.
- Waiting time, patterns of flow, and movement of people at various times of day.

After the evaluation, a blended design of light classical, smooth jazz, ambient, and world music is recommended to provide a variety of harmonic experiences and to produce an atmosphere of energized relaxation. Additionally, a system of harmonic zones is implemented to insure that each area has a unique personality, modified throughout the day and night.

Additional information on Harmonic HealthCare and Don Campbell:

ThePowerOfSound.com/HospitalSounds

MuViCure—Audiovisual Therapy (Denmark)

When two creative spirits collaborate, the results are sometimes magic. Add a little science, and the project can become serious. Put a composer/musician together with an award-winning filmmaker, both with an interest in healing, and you have MuViCure.

Niels Eje (music) and Bjorn Wennerwald (photography) have created an exciting venture of significance. Six years of international research later, MuViCure is about to become well known throughout Europe and the United States. And well it should. Eje and Wennerwald have created a beautiful symbiosis of therapeutically designed sound tracks in tandem with visual entrainment. The movies are gentle and soft images of nature. The sound tracks are sweet and take advantage of the laws of entrainment. By stimulating two major senses—vision and hearing—sensory integration is now seriously engaged on an emotional and physiological level. This is moviemaking put to good use!

MuViCure programs are designed to address issues of anxiety, pain relief, posttraumatic stress disorder, and general well-being. The goal is to provide

a soothing effect. Stimulating the mind with positive impressions also recaptures optimistic memories. In line with globalization, the music and visuals are benign and universal, working across cultural and geographical borders.

The music is composed for acoustic classical instruments and then mixed with original nature sounds. It is based on a slow pulse equaling the human heartbeat and deliberately avoids loud dynamic peaks. Since 1998, Eje's music has been tested on thousands of hospital patients. After six years of ongoing feedback from hospital patients, doctors, and nurses, Wennerwald's light, color, feel, and pace have been finely tuned to generate different moods, precisely timed to match the music.

I believe the hospital environment will become a more effective partner in the healing process when television sets use these beautiful, slow images and the sounds of an oboe and cello fill the hallways.

Healing HealthCare Systems (United States)

Similar to MuViCure, this Nevada-based company develops media products and educational programs to assist health care organizations in providing clinical environments that are directly supportive of recovery. Founded by musicians Susan Mazer and Dallas Smith in 1992, HHCS was featured in the first edition of this book. However, I'd like to provide an update on this pioneering company.

Best known for its *Continuous Ambient Relaxation Environment (C.A.R.E.)* programming, which brings nature and soothing instrumental music into hospitals, Healing HealthCare Systems products include:

- The C.A.R.E. Channel—24-hour closed-circuit television programming
- C.A.R.E. With Music—instrumental music-only programming
- The Sondrex System Mk II—a portable patient music and communication system for patients undergoing surgery or other stressful medical procedures. A combination of a personal CD music system with a specially designed communications interface, this device allows the caregiver to speak to the patient at any time without removing the sound-insulating headphones.

CHAPTER 11

Animals and Sound

It would have never occurred to me to expand my exploration into the effects of music and sound beyond the human domain. Not for lack of curiosity, but simply because there is so much data about humans and *their* soundscapes to compile, consider, and put to good use. However, an ongoing practice for me is noticing what appears; it seems the universe has a way of steering us in important directions.

Lisa Spector is a concert pianist and a Juilliard Conservatory graduate. Not only is she an award-winning virtuoso, but she has another passion that is equal in weight—dogs! She just loves 'em! When she came to one of my seminars in 2003 with a puppy wearing a Guide Dogs for the Blind puppy-in-training jacket, I was curious but had no idea what the future held in store.

A few months later, Spector called me. After attending my workshop on therapeutic music and sound, she wanted to know if the same psychoacoustic principles that work with people could apply to canines. "Would you be willing to make a CD that I could sell in my local pet shop?" she asked. This simple invitation to think about tone, tempo, and pattern in relationship to other species caught my attention and ended up consuming the next five years of my life.

BIOACOUSTICS

To begin, I learned that there is a parallel universe to psychoacoustics* known as *bioacoustics*. This scientific discipline concentrates on sound and animals.

*The study of the effects of sound on the human nervous system. (See chapter 16.)

Wikipedia defines bioacoustics as

> *a cross-disciplinary science that combines biology and acoustics. Usually it refers to the investigation of sound production, dispersion through elastic media, and reception in animals, including humans. This involves neuro-physiological and anatomical basis of sound production and detection, and relation of acoustic signals to the medium they disperse through. The findings give us some evidence about the evolution of acoustic mechanisms, and from that, the evolution of animals that employ them.**

Digging deeper, I discovered that in addition to the study of how animals make sound and communicate with each other, some consider bioacoustics to include the effect of human sound on animals. This really caught my attention.

The more I know about the power of sonic energetics—physically, psychologically, mentally, spiritually—the greater a proponent of sonic activism I've become. Our soundspace has such an impact on everything around us, how can we not give it suitable attention? (See "Sympathetic Vibration and Propagation" about the use of sound on food-producing plants, chapter 17.)

Appropriate consideration of *soundspace* brings these questions to mind:

- What is the effect of our human sounds on animals and other physical domains?
- In this age of sustainable considerations, how do human sounds impact the environment?
- What is our level of responsibility? (This last question is asked most often by organizations such as the World Federation of Acoustic Ecology and the Noise Pollution Clearinghouse.)

It is these questions that spark my interest in sound and animals. As earth stewards, isn't it important to know how human-created sounds affect other realms—and adjust our output accordingly—just as we must consider the effect of human-created toxicity in air and water? Certainly, our carbon footprint is of vital consideration, and I am not suggesting that noise pollution is the same as unmitigated coal burning or polluting automobiles. However, don't pollutants, in all forms, contribute to a state of imbalance?

*Additional bioacoustic substrates of interest include *biomusic* and *zoomusicology*.

Another great benefit in considering the effect of sound on animals lies in the possibility that what we learn about animals and sound may give us a deeper understanding of our own sonic tolerances.

PEOPLE AND ANIMALS— DIFFERENT AUDITORY SENSIBILITIES?

At first consideration, one would think our auditory sensitivities would be far more refined than those of animals. But on deeper consideration, this actually is not the case.

Humans use their auditory capacity for a few primary functions: determination of personal safety (*Where's that siren?*), aesthetic preferences (*Bach or Beatles?*), and utility (*7.8 Hz helps me sleep*). Communication interweaves throughout.

Do animals put sound to work? Do animals have aesthetic preferences? While all animals use their sound sense for safety and communication, a 2009 Japanese research study on baby chimpanzees found musical preference to be scientifically verifiable. Researchers produced an extraordinary video showing a baby chimp repeatedly choosing consonant (harmonious) music over discordant in compositions.[1] In 2002, Irish animal researcher Deborah Wells showed us that slower classical music soothes dogs, while rock music can make them anxious.[2] Talk to any farmer who has experimented with music and they will tell you that country music calms their ponies and brings their cows in from the pasture, while classical music is better for milking and improves the growth rate in chickens. The answer of whether animals can demonstrate musical preferences continues to be scientifically proven.

In terms of animals and the employment of sound, there is no greater example than the bat or whale using sound (sonar) to see,[3] elephants using ultrasound (very low frequencies beneath the range of human hearing) to communicate, or the canine who uses sound to warn of impending danger. It is certainly no exaggeration to say that sound is a primary tool for animal survival.

People can read, speak, and depend on others for their safety. For domesticated animals, they too can get by with diminished auditory perception. However, put an animal in the wild, and if its sound sensibility is not dead accurate, it simply may not survive.

As I write, I watch a mother and two baby deer in my front yard. Their big ears are constantly moving and acutely tuned to the environment. Their

primary survival mechanisms are highly tuned ears and fleet feet. They can run away, very fast. But if their hearing is compromised, they won't survive the dogs, bears, people, or cars.

"THE WHISTLE HEARD AROUND THE WORLD"[4]

Dr. Patricia McConnell is a highly revered American animal behaviorist.[5] Her well-loved and bestselling books, mostly about canine behavior and training, emanate from her lifelong study of zoology. When *Through a Dog's Ear* was published (a book I coauthored in 2008 with veterinary neurologist Susan Wagner),[6] McConnell was immediately drawn to our exploration of the effects of music and sound on dogs.

She was kind enough to share with me her 1990 doctoral thesis, "Acoustic Structure and Receiver Response in Domestic Dogs, *Canis familiaris.*" McConnell explored a hypothesis that short, rapidly repeated rising notes increased motor activity levels in animals, and that longer, continuous, descending notes decreased activity.

In her research, she interviewed and observed 104 professional animal trainers from around the world, working with diverse animal populations. From camels to cats and donkeys to dogs, McConnell realized that the way we say, "Here kitty kitty kitty" (short, rapidly repeated rising notes) to attract the attention of a bored feline and, "Whoa" (longer, continuous descending notes) to stop a horse had antecedents that cut across cultures and time.

What stood out for me, when I read McConnell's research, was the overlay to Dr. Alfred Tomatis's philosophy about how sound affects *people:* high sounds tend to *charge* the nervous system, while lower sounds *discharge;* intricate patterns draw us into *active listening*, easy patterns bring us to *passive hearing* (to habituate).

In Dr. McConnell's painstaking analysis of sound with animals, her short/broadband notes that *stimulate* activity and longer, continuous/narrow-band notes that *inhibit* activity completely fit into the Tomatis observation and prescription for the use of intentional sound with people.

Yet another linkage in our understanding of the symbiotic nature of sound.

EMOTIONS AND THE BRAIN— ANIMALS *AND PEOPLE*

Dr. Jaak Panksepp is an enormously prodigious and internationally recognized neuroscientist.[7] One of his textbooks, *Affective Neuroscience: The Foundations of Human and Animal Emotions,* has helped inaugurate a new field of inquiry that probes the affective infrastructure of the mammalian brain. He says, "Our working assumption is that all of consciousness was built on affective value systems during the long course of brain evolution." Currently, his work is aimed at deepening and broadening our understanding of animal and human mental health issues.

Temple Grandin, Ph.D., is an authority on animal behavior with an extraordinary vantage point. She is one of the world's most accomplished adults—with autism. Her 2009 book, *Animals Make Us Human,* follows the 2005 bestseller, *Animals in Translation: Using the Mysteries of Autism to Decode Animal Behavior.*[8] She says, "People with Asperger's or dyslexia are often good with animals because their thinking is more sensory-based than word-based. Many times I have told my students that to understand animals you need to get away from language and think in pictures, sounds, touch sensations, smells, and tastes."[9]

Grandin believes that all animals *and people* have the same "core emotion" system in the brain. In *Animals Make Us Human,* she shares her experience of, when dissecting a pig's brain, having difficulty distinguishing the difference between a pig and human brain in the lower sections. "Human beings have a much bigger neocortex," she says, "but the core emotions aren't in the neocortex. They're in the lower-down part of the brain."[10]

In *Animals Make Us Human,* Grandin's theoretical basis about animals's core emotions[11] emanates from Panksepp's theories of "blue-ribbon emotions": seeking, rage, fear, panic, lust, care, and play. His extensive lab research proves that when particular sections of the brain system are stimulated for one of the core emotions, the research animal will always give the same behavior. Grandin comments on this: "If you stimulate the *anger* system, the animal snarls and bites. If you stimulate the *fear* system, the animal freezes or runs away. Electrodes in the *social attachment* system cause the animal to make separation calls, and electrodes in the *seeking* system make the animal start moving forward, sniffing, and exploring its environment." She concludes, "When you stimulate these parts of the brain in people, they don't snarl and bite, but they report the same emotions animals show."[12]

Grandin's work is based on creating good mental welfare for animals. She feels that the best guidelines revolve around the core emotion systems in the brain. Her advice is simple: "Don't stimulate rage, fear, and panic if you can help it, and do stimulate seeking and also play. Provide environments that will keep the animal occupied and prevent the development of stereotypies (abnormal repetitive behaviors)."[13] This is advice for dealing with animals. The boundaries between people and nonhuman animals seem to become more difficult to differentiate.

What can we take from this? Animals and people share the same emotions. We clearly may react or control them differently (or not!). Our emotions are brain-based and stimulated by our perception of our sensory environment. Bringing it back around to sound (including music), how can we create sonic environments most conducive to optimal performance? I've been asking that question for more than two decades concerning people. Incorporating the understanding of Grandin and Panksepp, why would the question be any different for animals? And yet, why don't we normally ask it?

If the emotions of people and animals are the same, neurologically hard-wired and perceived through sensory organs, wouldn't we be kind and careful with what (sonic) energies we send through the air?

I find as I write this section . . . I feel a silence, a delicate fragileness, a sense of reverence. This summarization of such deep wisdom, a revealing of the obvious, now understood on the most scientific levels . . . is only one more reminder of the interconnectedness between all beings, cohabitants on planet Earth.

ONE HARP AND ONE ANIMAL AT A TIME

The Work of Sue Raimond

Sue Raimond is a pioneer in the field of harp enrichment therapy for animals. While she also performs in hospitals for cancer and pediatric patients and does hospice work during the final hours of life, her greatest pleasure is playing for animals—the wild ones kept in captivity, often under great duress. *"My motivation is the relief of pain, stress, and anxiety . . . one harp and one animal at a time."*

In 2004, Raimond established a program for the elephants at San Diego Wild Animal Park. Since that time, she's played for gorillas, zebras, and

giraffes at Boston's Franklin Park Zoo. Dallas veterinarians, ranchers, and shelters have also had a chance to learn how to use harp enrichment therapy at their facilities to calm their animals and even eliminate negative behaviors such as cribbing. A rescue facility in southern California allowed Raimond to work with their big cats with surprising results: tigers snoozing in water-filled tubs, ignoring mealtime. Petsburg USA invited Raimond to experiment with a pack of twenty undomesticated Alaskan wolves. While amazed animal behaviorists watched, the entire pack of wolves was filmed—asleep, including the alpha male.

As word spread of her success, BioWhittaker, one of the largest animal research facilities in America, asked her to come and test music with their monkeys. Even the U.S. Army Medical Research Institute of Infectious Diseases has asked Raimond about the use of recorded music for their lab animals.

What does she do, and why are all these people so eager to have her play a wooden harp for wild animals?

For Raimond's delightful stories and further information about frequencies, modes, and the Three-Minute Access:

ThePowerOfSound.com/Raimond

THROUGH A DOG'S EAR

For the final section of this chapter, I'm circling back to the story of Lisa Spector, pianist and dog lover—for whom I'm so grateful! Spector's suggestion that I create soundwork for the benefit of dogs propelled me into a larger arena of the cross-species considerations of sound. What is the effect of human sound on animals, and what does this teach us about ourselves?

In 2003, Spector and I recorded four albums of classical music with varying degrees of tempo and complexity (harmonic, orchestration, and arrangement). Between 2004 and 2006, the music was tested on 150 dogs in a research project conducted by veterinary neurologist, Susan Wagner. In 2008, *Through a Dog's Ear* was published.[14] I cowrote this book with Dr. Wagner, exploring the impact of an overstimulating world on both humans and their dogs. Coinciding with the book, a *Dog's Ear* CD music series was also released.

In the years since 2003, I've often mused about what motivated my decision to move my work with tone, tempo, and pattern into the doghouse.

- In 2005, there were 75 million dogs in 43 million American households.*
- I've never seen a dog pant or wag its tail in rhythm while listening to music.

Bottom line . . . I wanted to know why so many canines had behavioral issues, and if they could entrain.

The following excerpt from *Through a Dog's Ear* explains the research conducted on music and canines.

> Recording the four classical CDs for dogs involved the same psychoacoustic principles used in recordings proven to provide deep human relaxation. Our belief is that there is a cost to the nervous and immune system for all sensory analysis, and when we are stressed or not well, we have little energy to spare. Yet, Dr. Alfred Tomatis also taught that sound is a vital and nutritive energy, important for healthy nervous system function.
>
> Consequently, years have been spent trying to find ways to provide life-enhancing sound with a minimal depletion of the nervous system. As noted earlier, this concept is called *simple sound.*
>
> When we first considered recording music for dogs, we had absolutely no idea if human brain wave states and heart rates corresponded in any way to that of the canine range. However, based on initial research, it seemed a good bet that what affected humans would have some kind of effect on dogs as well. We just did not know the extent.
>
> From previous studies, we understood music did, in fact, have an effect on companion and farm animals. The value of auditory enrichment had been researched with a variety of species, including horses, cattle, birds, and primates. However, we were surprised to see that only one canine-specific study had been conducted.

Dr. Deborah Wells, Ireland

In 2002, Belfast-based psychologist and animal behaviorist Deborah Wells undertook a research program to determine the influence of five types of

*Between 2003 and 2008, the pet industry was the second largest retail sector, only behind consumer electronics. The $36 billion per year spent on American pets in 2003 increased to $50 billion annual expenditures in 2008.

auditory stimulation: human conversation, classical music, heavy metal music, pop music, and a silent control (no music at all).[15] From Wells's study, we came to understand that classical music had a marked soothing effect on dogs in animal shelters when compared with the other types of auditory stimulation. In the discussion section of her published research, Wells stated, "Classical music resulted in dogs spending more of their time resting than any of the other experimental conditions of auditory stimulation. This type of music also resulted in a significantly lower level of barking. Research suggests that calming music may have a beneficial effect on humans, resulting in diminished agitation, improved mood and lower levels of stress. Although the specific effect of classical music on dogs remains unknown, the findings from this study suggest that it may, as in humans, have a calming influence." She concluded that heavy metal agitated the dogs, indicated by increased frequencies of standing and barking, and that neither human conversation nor pop music had any apparent effect on the dog's behaviors, perhaps due to habituation to radio exposure.

Wells stated, "Further work is still required to unravel the specific acoustic elements that dogs respond to." That challenge inspired us to take our bioacoustic research where no one had gone before.

THE BIOACOUSTIC RESEARCH & DEVELOPMENT PROJECT, UNITED STATES

Understanding that something about classical music was having an optimum effect on dogs, we endeavored to take Wells's work one step further. The purpose of the BioAcoustic Research & Development (BARD) project[16] was to investigate the effects of multiple types of classical music on the behavior of dogs in kennel and home environments. The music was chosen and arranged according to the principles of entrainment (beats per minute) and harmonic complexity (active listening versus passive hearing). We know that dogs have the same brain-wave patterns as humans. However, dogs' heart rates vary according to size; the larger the dog, the slower the heart rate. The tempos used in this project were based on an average-size dog.

We also recognized that domesticated animals possess more highly tuned hearing than people, yet we did not know if animal cerebral function would allow them to recognize sonic relationships (i.e., intervals, harmonies, and fast or slow external rhythms). In short, effectuating change in the human

nervous system with sound and music is known, but what would be the result using the same principles on dogs?

After highly specific recordings were made, we created two pilot studies, involving more than 150 dogs. Between June 2004 and September 2005, dogs were observed while listening to different combinations of the recordings Lisa Spector performed for the project, as well as control CDs, consisting of nonpsychoacoustically arranged classical music.

BARD PILOT STUDIES

Pilot I. The purpose of this first pilot was to determine the efficacy of external rhythm and pattern identification on canines in the kennel and home environments. Four albums of psychoacoustically designed classical music were tested: two albums of solo piano at varying tempos and two albums of piano trios, also at varying tempos. The results suggest that all classical music doesn't have the same effect on behavior in dogs:

- In the kennel environment, over 70 percent of the dogs became calmer with exposure to simplified, 50 to 60 beats per minute (bpm), solo piano and trio music.
- In the home environment, solo piano pieces introduced at 50 to 60 bpm resulted in an average of 85 percent of the dogs becoming calm, and over half the dogs went to sleep.

Pilot I Summary. Instrumentation and tempo of the classical music can produce marked differences in results. Solo instruments, slower tempos, and less complex arrangements had a greater calming effect than faster selections with more complex harmonic and orchestral content.

Pilot II. The purpose of the second pilot was to determine if music arranged according to psychoacoustic principles would have an effect on specific anxiety issues in dogs, such as fear of separation, thunderstorms, and fireworks. Upon review of the data from Pilot I, it was determined that the simple and slow piano CD showed the most consistent results for calming dogs in both kennel and home environments. Because many guardians turn the radio on for their pets when they leave home or when a thunderstorm is approaching, another CD of standard classical music was chosen for comparison. This music was taken from the play list of a San Francisco

classical radio station and was not psychoacoustically rearranged.

Ten dogs with anxiety were used in Pilot II. Their specific anxieties stemmed from the following:

- Other dogs or children
- Visitors in the home environment
- Thunderstorms
- Riding in the car
- Excessive need for attention—pawing at guardian
- Separation anxiety
- Fireworks

Pilot II Summary. Results showed 70 percent of anxiety behaviors were reduced with psychoacoustically designed music, while 36 percent of anxiety behaviors were reduced with the nonpsychoacoustic control CD. Both CDs calmed the dogs enough to make them lie down. However, it appears that the psychoacoustically designed music, with slower tempos and simpler arrangements and sounds, is more effective in reducing anxiety.

For complete research analysis of the BARD dog studies, visit:
www.ThroughADogsEar.com

COMMENTS ON THE BARD STUDY

What is fascinating, from a psychoacoustician's viewpoint, is the fact that dogs were reacting in a similar manner to music that had been created for specific effects on people. In other words, dogs could be *entrained*—heart rate, brain waves, and breath slowed or speeded up when influenced by external rhythms—just as with people. It is also intriguing to note that the *complexity* of sound affected dogs in a similar fashion as it does people: the greater complexity in the music, the more energy required to decipher it. Likewise, the simpler the sound, the greater the relaxation response.

The fact that this simple pattern identification process had an effect on dogs with anxiety issues is even more startling for it suggests that dogs suffer from overstimulation in the same way that people do. Stimulus is defined as something that produces a temporary increase of physiological activity. We know from the extraordinary work of Dr. Alfred Tomatis that high-pitched

(treble) sounds will stimulate and lower (bass) sounds destimulate the nervous system. (The first 80 percent of hearing cells in the inner ear process mid-high frequency tones. The remaining 20 percent of the cells process mid-low sounds. Tomatis discovered that if the ear is overwhelmed with too many low sounds, fatigue occurs and the brain does not receive the full benefit of the sonic energy. High sounds, he observed, create optimal stimulation.)

Of the five CDs used in the combined studies, the single CD with the most startling results was one designed specifically for human calmness. This CD is the first in the *Through a Dog's Ear* series.

Entrainment—the process whereby our internal pulses will match a periodic rhythm—is easily observed in people who are tapping their toes and moving their heads to a rhythm. As we noted earlier, we have never witnessed a dog that pants or wags its tail to a beat. However, the results of these studies show that even without physical demonstration of rhythmic entrainment, internal systems are still speeding up or slowing down to match external rhythmic stimuli. The ramifications of this are great. Our canine companions are fully impacted by the sonic landscapes in which we surround them.[17]

THROUGH A DOG'S EAR SHELTER PROGRAM

The TADE Shelter Program provides free CDs for qualified animal shelters and nonprofit rescues. As of this writing, more than one hundred organizations participate in the program. If you know of a nonprofit organization that would be interested in the clinically demonstrated audio programs, further information can be found at www.ThroughADogsEar.com.

The Effect of Music on Animals: Research of Note

Abstracts that address the effects of music on animals and can be found at:

ThePowerOfSound.com/AnimalResearch

SUMMARY

The dates of these leading-edge research studies into the effect of music on animals range from only 2008 to 2010. There was more research in these three years than in the ten before it. What is the cause of this proliferation?

Why are so many researchers, from Japan to the United Kingdom to the United States, looking at music and animals? As neuroscientist Aniruddh D. Patel sees it, if a bird can dance in rhythm "this would inform debates over the evolutionary status of music." Neuroscientists are also telling us that if we can understand how the human brain processes music in all its complexity, then it becomes another model for understanding nonmusical brain functioning as well.

What I like most about the increased scientific attention to music and animals is the possibility that as we understand animal preferences to human or species-specific music, the effect on their nervous systems, and their ability to entrain with external rhythms, we can use this knowledge to adapt our sonic environments for the animal domain's health and wellness. Part of sharing the planet. . . . But we, as humans, have the bigger loudspeakers and heretofore, the animals have had to just put up with it. They've had no control of the volume dial.

Where does an exploration about animals and sound leave us? The purpose of this chapter has been to lay the groundwork for a larger conversation about sound ecology. Because of the understanding I gained from working with music and dogs, I've endeavored to create an increased awareness about how human-created sounds affect other domains. What is our responsibility in this arena, to understand and adjust accordingly?

The research involved in the writing of *Through a Dog's Ear* taught me that the animal (and plant) domain has a wisdom and inherently creative survival arc of its own. However, how many of us have really considered the concept of a sonic footprint in our homes, neighborhoods, cities, and oceans, let alone within ourselves? The quality of interconnection and consequences thereof depend on our increased awareness.

For an updating online resource involving animals, music, and sound, visit ThePowerOfSound.com/Animals

CHAPTER 12

CURRENT SONIC MEDIA

Due to the technological advances of digitized sound, iPods and iTunes, wireless Internet, satellite access, and mobile Internet devices, there has never been a time when sound content and delivery systems were more synchronized for everyday, anytime access and use.

From this writer's point of view, the world of soundwork took a huge step forward when Apple Computer, under Steve Jobs, created the iPod and iTunes. The three forms of information downloaded through the Internet are words, images, and sound. As the major clearinghouse for digital information, iTunes makes it possible, within seconds, to download and purchase packets of digital information—songs, podcasts, videos, and movies. As far as I'm concerned, the content has not yet caught up with this fantastic twenty-first-century hardware; the delivery medium has outpaced the aesthetics.

What are breakthrough benefits for soundwork?

- Tomatis and other sound therapies: phone in a *voiceprint* and new protocols are created in an office far away, waiting to be downloaded onto your home computer and iPod. Net effect: therapeutic applications are now available anywhere regardless of patient's ability to access a practitioner's office. Virtual sound therapy through fiber optics!
- Specialized sound for institutions: following the lead of Muzak (originators of satellite feeds to retail outlets), hospitals and other institutional settings can now receive intricate prerecorded sonic environments—all through wireless connections. (See Progressive Sound Health for the Hospital Environment, chapter 10.)

- iPhones: in the day and age of mobile Internet devices, one only needs a "smart" cell phone connection to access the Internet. This means that specialized "Apps" can be easily accessed and used and that any sound track available on the Internet can be in your ears within moments. Additionally, 2010 estimates are that hundreds of thousands of pieces of music have been digitized and are available for download. Thirty billion songs were downloaded free through peer-to-peer file sharing in 2005.[1]

Online at ThePowerOfSound.com, a sampling of interesting nonmedical, technology-specific applications of sound can be found. Some are old with a new twist. Others show the power of imagination tied to technological advances. In nascent stages, these technologies are a portent of what sonic life will be like in the coming decades. Included you will find:

- Muzak-Sensory Media
- The Beamz
- Sight Through Sound—A Device that "Sees" the World Through Hearing
- The iPhone's Voice Control
- The Sounds of Google Earth
- The Temple of Sacred Sound (Jonathan Goldman)
- Natural Frequency Music as a Healing Tool (Alan Howarth)

ThePowerOfSound.com/SonicMedia

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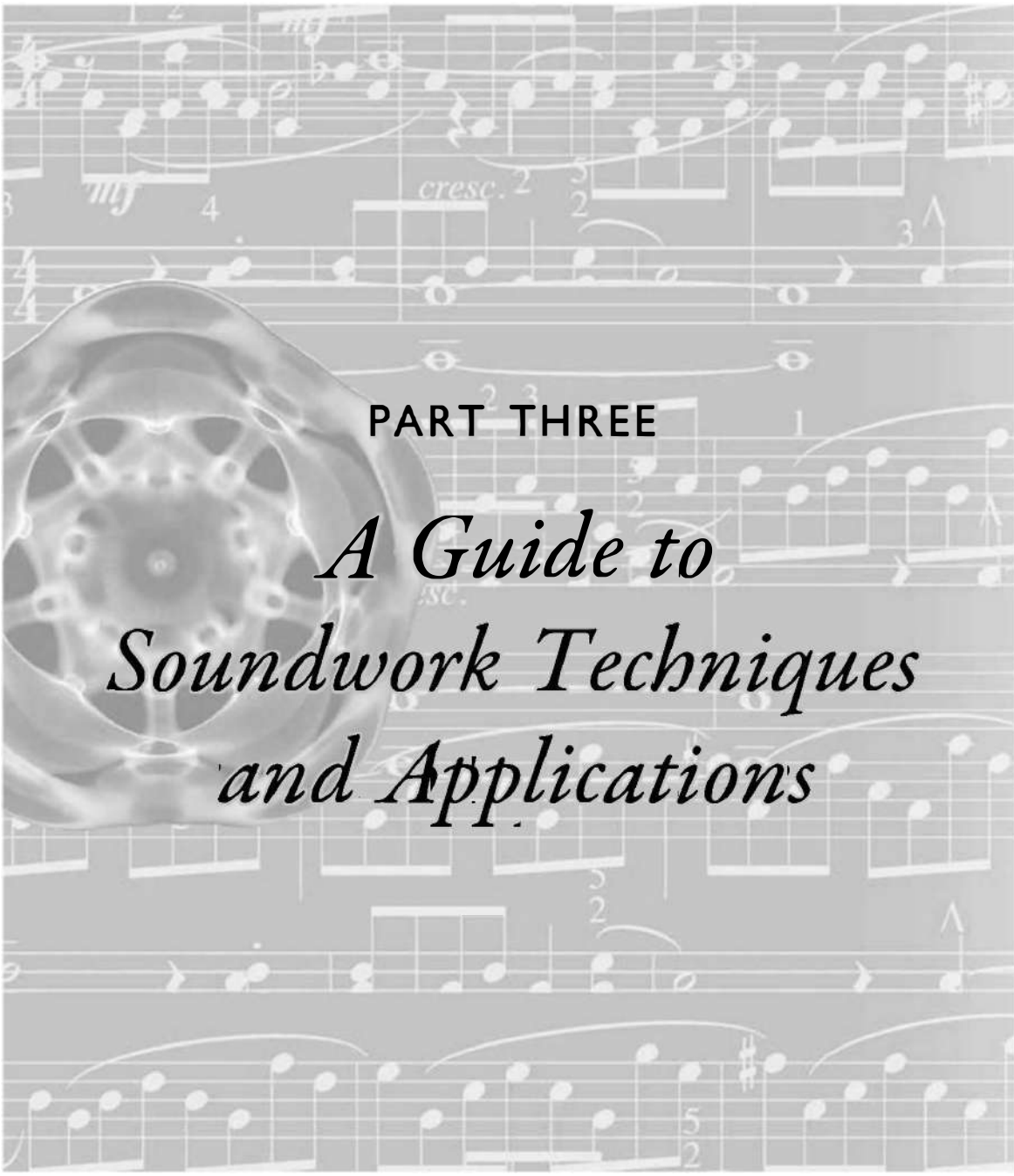

PART THREE

A Guide to Soundwork Techniques and Applications

CHAPTER 13

A Matter of Distinctions

In part 1, I explored the nature of sound and hearing. Part 2 suggested personal applications of a new sound awareness. Now let's turn our attention to the professional applications of soundwork techniques, the therapeutic uses of sound, and sonic neurotechnologies. Psychoacoustics is the overarching theme under which I will explore these topics.

As I have discussed, psychoacoustics is the study of the perception of sound. How we perceive sound can be broken down into how we listen, what our psychological responses are, and what the physiological effects of music and sound are on the human nervous system.

In this context, *applied psychoacoustics* refers to the practical application of music and sound. The subject of *The Power of Sound,* in its entirety, is about applied psychoacoustics. The level of specificity here in part 3, however, will be appreciated by professionals who wish to integrate soundwork into their health care practices, musicians who want to focus their craft on psycho-acoustically designed programs, and educators who want to fully understand the components of applied music and sound. Understanding the inner mechanics of psychoacoustic programs will be of value to all readers.

To start, a few subtle yet important delineations are appropriate. Let's compare sound therapy and music therapy, healing and curing, and tone and music.

SOUND THERAPY AND MUSIC THERAPY

Over the past few decades, new forms of auditory-based therapeutic practices have been gaining momentum. In this book, I refer to the use of sound that is employed as an agent of change as *soundwork*. Joining the ancient global wisdom of indigenous healers with the high-technology precision of the Western world, individuals are now able to use sound as a vibrational tool of transformation—and know what and why.

According to N. M. Weinberger, a sound researcher and archivist of music research at the University of California, Irvine, research into the neurological reactions and effects of music has grown tremendously in the last ten years. The major reason for this is recent development of imaging technologies to scan the activity of the human brain.[1]

Some call this newly burgeoning field sound therapy. I prefer to use the term *soundwork* because the term *therapy* generically implies healing or fixing. The use of sound to effect change goes far beyond fixing. Controlled vibrational interaction can also be transformational and of great value in enhancing what already works in our lives. Therefore, *soundwork* applies to the intentional use of music and sound for either therapeutic or life-enhancement purposes.

In the past fifty years, music therapists have combined the use of music with psychological and physiological applications in hospitals and in private practice. The success of music therapy has rendered it a legitimate modality within the domain of Western medicine. The up-and-coming field of soundwork, however, presents a radically different approach based on the powerful interaction between the vibrational frequencies within sound and the body and mind.

While music therapy and sound therapy seem quite similar because they both use sound to create change, they are actually very different approaches. Music therapy is psychologically oriented, using familiar music to enhance relaxation, comfort, and enjoyment. (For more on music therapy, see the American Music Therapy Association website.) Sound therapy, on the other hand, uses the principles of resonance, entrainment, and vibration to effect changes in tissues and organs; it is thus neurologically oriented.

I must point out that soundwork does not preclude music therapy. Psychological reactions will take place whenever music is present. Likewise, music therapists cause vibrational interactions to take place when they play a familiar melody to trigger memory. I make the distinction because although

soundwork and music therapy often use the same material, the primary approach and intention may be different.

For a 2010 assessment of "Music Therapy and Therapeutic Bedside Musicians" and "Differentiated Aspects of Music Therapy/Music and Sound Healing" see chapter 10.

HEALING AND CURING

The goal of soundwork is the enhancement of human function through the use of music and sound. This broad approach includes enhancement of what works as well as healing of what could be better. In the context of soundwork, I define *healing* as "the process of regaining balance." *Balance* is, in turn, "the continuing development of equanimity." In balance, right action seems to occur: the body's innate wisdom compensates and adjusts. Healing looks beyond the symptom to the root of the distress; it addresses the gestalt of the mind, heart, spirit, and body. Healing is different from curing: sometimes we find healing but not a cure. We may find balance and ease yet still suffer—even die. There can be healing in dying, contrary to the view in Western medicine that sees death as failure.

However, to label a modality as *healing* may undermine its effectiveness and prevent us from understanding it. This is especially true when dealing with subtle energy or vibrational formats. The effect of music and sound is influenced by mood, fatigue, brain waves, heart rate, and temperature. What works for me may not work for you. What works today may cause a different reaction tomorrow. There are no guarantees. To find the most effective individual prescription of sound is the challenge. Therefore, I recommend great caution and modesty in labeling intentionally created music and sound programs. Says Weinberger, "The secrets of nature don't reveal themselves easily. . . . Understanding the relationship between music and human mental processes and behavior requires a commitment of resources, time, and the dedication of skilled investigators."[2]

TONE AND MUSIC

When soundwork is focused therapeutically, there is a marked difference between the use of music, with its rhythmic and harmonic complexity, and the use of single tones or extremely simple tonal patterns. Dr. Randall

McClellan has discovered that the therapeutic uses of music are characterized by two distinct approaches: songs made up of rhythm and melody have traditionally been used for general healing purposes, whereas specific tones and mantras have been used for their vibrational properties to treat specific parts of the body. The significance of these approaches is that they "represent two distinctive but equally valid philosophies and methods." A song, "which for the sake of convenience may be referred to as *music healing,* begins the healing process through its influence on the emotions and mind first and the physical body second." A tone or mantra, on the other hand, "which may be referred to as *sound healing,* treats the body through resonance first and affects the emotions and mind second."[3]

Songs use the mind and emotions as a doorway in. Again, this psychological approach is the basis of music therapy. Tones in sound therapy go straight for the physiological impact, directly resonating the body.

In the future, sound healing (through tones) may be considered prescriptive and comparable to highly specific pharmaceutical drugs, while music healing may be perceived as an over-the-counter remedy, effective and generalized. In time, we may find *sound* healing most effective in alleviating chronic physical conditions and *music* healing part of the regimen of well-body maintenance. People may come to incorporate a daily sound bath into their schedules, recognizing sound health as just as necessary for overall wellness as daily food and exercise.

CHAPTER 14

The Building Blocks of Therapeutic Sound

There are many tools in the musician's toolbox. Against the backdrop of tonal centers, counterpoint, and rhythm, a player understands the use of different scales. In the West, a scale is an arrangement of notes in a specific order of whole and half steps. Trained musicians know where tone rows make sense and when a pentatonic blues scale is creatively congruent. With rhythm, a musician understands that a time signature of 4/4 (four quarter notes to a measure) will not work for a waltz (3/4) and that syncopated polyrhythms are great for jazz but not so good for lullabies. Timbre, harmony, rhythm . . . these are some of the building blocks of music.

Adding psychoacoustics to the musical canvas requires understanding resonance and entrainment. These elements are essentially the scales of psychoacoustic composition; the knowledge of resonance then informs the tones and rhythms that we play. Once a musician moves into the realm of application-specific composition, many rules change. Some of the building blocks of music take on another dimension when applied in this manner. For example, in a psychoacoustic context, the timbre—or the color of a sound—is looked on as tone. This triggers a thought process about how and what this tone resonates. Rhythm implies entrainment. Now the beat is related to the desired rate of internal pulses. And harmony is not so much about consonance and dissonance as it is about sonic density and the effect of data,

complex or simple, on the nervous system. In this chapter I look at musical components from a different slant—a psychoacoustic vantage point.

In her highly regarded book *Sounding the Inner Landscape: Music as Medicine* (see the bibliography), Kay Gardner identifies the following therapeutic elements of music:

Drone. A drone is a long, uninterrupted sound, or set of sounds, underneath the music. The musical term *ostinato*, or pedal point, refers to an accompaniment figure that is repeated.[1] In Western music, a drone might consist of a bass line of a few low tones. Melody lines are then played against the drone by other instruments. Drones are quite common in Indian music. An open-stringed instrument such as a tamboura or vina will play a repeating chord consisting of three or four notes. A sitar will then play a melody over the drone. Bagpipes also have nonchanging low tones that accompany higher melodic tones. Drone tones are usually long and low. Like a bed of sound, drones provide an emotional sense of security. As single tones, drones may be a vehicle for resonating specific parts of the body.

Repetition. When a musical phrase is repeated, the listener becomes comfortable. Repetition creates a hypnotic or relaxing effect in which the listener is moved into a receptive state. Repetition with rhythm or simple melodic phrases can create a trance state.

Rhythm. The effect of rhythm springs from the natural reaction of pulses in the body: heartbeat, breath cycle, brain waves. Rhythm may accelerate or slow these pulses through the vehicle of entrainment.

Harmony. The emotional content of music is contained in its harmony. With the use of inner harmonic phrases, dissonance resolves to consonance and tension is released. Complex harmony challenges the listener emotionally; simple harmony is used for meditation, centering, and visualization.

Melody. This is the primary element that we hear in a composition. It is a succession of single notes. The power of melody is its ability to take away the listener from physical awareness. In guided visualization, melody allows visual fantasies to take shape. Beginning with Pythagoras, melody has been prescribed as anesthesia because of its power to soothe.[2]

Instrumental colors. In Western music, the study of instrumental color is known as orchestration. The timbre of each instrument is determined by the uniqueness of its harmonic content. This is what makes

a violin, a trombone, and an oboe sound so distinct. Each instrument resonates the listener in a specific area of the body.

Form. The structure underneath all the other elements is the form. Form is the organization of a composition. For example, a sonata form consists of three main sections: exposition, development, and recapitulation. (In lay terms, a sonata form is like a well-organized speech: you are told what you will hear, you hear the themes with embellishment, and you are reminded of what you just heard.) The form of a pop song is usually verse, verse, chorus, verse, chorus, chorus, bridge, modulated verse, chorus infinitum. Different styles of music have their own forms. Be it a fugue or a morning raga, the form provides a sense of stability.

Intent. Perhaps the most important element in therapeutic music is the intention of the musical team. Is the music offered with pure intent? Is it possible that music is a carrier wave for the vibration of those playing and composing? If the choice of harmonies, colors, and intervals is a reflection of the psychological and physiological tonus of the person creating the music, couldn't this information be transmitted in sound like an electrical impulse through a fiber-optic cable? I believe that this is the case. I don't know it from research: it is my intuitive and anecdotal truth. Consider the following . . .

If I write a piece of music to salve a breaking heart and I'm good at my compositional job, this music will resonate with other people who share a memory of that occurrence. As fellow humans, perhaps we recognize the intervals between the tones, or the tensions and releases. Maybe we see—or in this case, hear—ourselves in others.

When we listen to music, our psychological defenses usually are down. We are open and vulnerable on the emotional and psychic levels. If we "see" sound as a sonic snapshot of another's psyche, don't we then bathe ourselves in another?

This is all very subtle and subjective. I can refute these hypotheses with other examples. Some of Beethoven's most beautiful works were written while he was in pain, but you don't hear it in the music. Other compositions have been written by hateful racists, yet you wouldn't know it unless someone told you. Or would you? Is it a matter of sensitivity? Where is the line of believability on this issue?

Music is a powerful energy transmission, yet its power lies in its subtlety.

We may not *consciously* be aware of the intention of those behind our music, but our higher consciousness—the inherent wisdom that knows how to grow a human out of two cells—reads the information encoded inside the sound wave.

If a musician is angry or scared when making a recording, this emotion can be subtly recognized in the phrasing or dynamics. This may not be discernible to our normal ear, but it is interpreted and recognized as fear or anger in some part of some auditory center of the brain. Or if a composer such as Brahms consciously prayed for divine intervention before he put pen to paper and prepared himself to write down the music he "heard," we will recognize those sounds because we have the ability to "hear" on that level as well. I believe that in our gross physical bodies, auditory sensitivity is pretty dense. Perhaps recognition of intentionality takes place in the unused gray matter.

The iso principle. *Iso* means "equal." Applied to therapeutic music, the iso principle consists of initially matching the mood of the music to that of the listener and then slowly changing that mood, tempo, or timbre in the direction you want to bring the listener. Essentially, it is a gentle coaxing of listeners from their existing body and mind-set, by means of something familiar, to another space conducive to the sound application.

A composer must always consider the audience. This is true for a film composer as well as a pop songwriter. In a psychoacoustic context, the end listener is especially important. If you are writing for a bedridden cancer patient, the tempos, orchestration, structure, and conclusion you choose will be different from those you would incorporate into a sound track for healthy people unwinding from a hectic day.

After the audience question is answered, the next issue concerns rhythmic destination. This is where the iso principle applies. Let's assume that your listeners are at the end of their days. Chances are they are in a low beta brain-wave state (12–15 Hz) because they have been mentally active all day and are starting to slow down. By first rhythmically matching their existing brain wave and heartbeat states, then gradually slowing down the pace, you have met them at their own tempo. Through the process of entrainment, they will essentially follow you as you gradually slow the tempo. If you created a tempo *too* different from their existing rate, they would most likely not be able to relate sonically; they'd simply tune you out. Your efforts become ineffective at this point. The idea is to bring about gradual change.

Harmonics. The harmonics of sound may be the most important part of actual sound waves. I have not been able to locate verifiable scientific research into the effects of harmonics. However, the effects of harmonic resonance on the electrical fields of the body have been referred to in numerous anecdotal explorations of sound.[3] The natural acoustical harmonic frequencies duplicate ratios found throughout nature, the human body, classic art, and architecture. Let's take a look.

Simply put, harmonics are a series of tones that vibrate above a fundamental note. Known as *overtones* or *partials,* these softer tones are pure, clear sounds. Harmonics exist in our voices and in all instruments and are responsible for the unique sounds of each.[4] Even if you cannot hear the harmonics, they are there.

If I play a low C on a piano and hold down the key, you will hear a series of other tones begin to sound. They will not be as loud as the fundamental note (the struck C note), but you will hear other strings on the piano begin to resonate and sound. Many of these sounds will be octaves of the original C note. Other tones will be intervals of a fifth or a third. Within the overtone series triggered by any single note, almost every other note is sounding, although you cannot consciously hear them all—especially not the higher overtones. But you can hear the first few harmonics.

One of the most interesting things about harmonics is the frequency ratio between the successive notes in any harmonic series. Each note in the harmonic series is a geometric multiple of the fundamental. The first overtone is vibrating twice as fast as the fundamental at a ratio of 2:1. The second overtone is vibrating three times as fast as the fundamental (3:1). This continues up the series; for instance, the eighth overtone is vibrating nine times as fast (9:1), and so on. Each of the different speed frequencies corresponds to a different note.

This is how harmonics relate to therapeutics—through the concept of wholeness. Sound researcher Jonathan Goldman states, "In the 1920s Hans Kayser, a German scientist, developed a theory of world harmonics based on the Lambdoma.* Kayser found that the principles of harmonious structure in nature and the fundamentals of harmonics were essentially the same . . . that the whole number ratios of musical harmonics corresponds to an underlying framework existing in chemistry, physics, crystallography, astronomy, archi-

*The Lambdoma, also known as the Pythagorean Table, is an ancient musical mathematical theory that relates music to ratios. It is credited to Pythagoras.

tecture, spectroanalysis, botany, and the study of other natural sciences."[5]

Herein lies the interrelationship of music with the rest of the world and beyond. The harmonic ratios found between certain intervals (the distance in pitch between two notes) corresponds to ratios found in DNA, in the proportion of many (but not all) leaves, flowers, fruits, shells, and some animals. The Golden Section is a specific geometric proportion. The use of this formula can be seen in Egyptian pyramids (thirteenth century BCE), in the Parthenon at Athens (fifth century BCE), as well as in other ancient buildings in Athens and Rome.[6] According to Goldman, "The Golden Section often involves proportions which relate to the ratios found in the major sixth (3:5) and minor sixth (5:8). The proportions of the body adhere to these ratios."[7]

Gardner poses the question, "Why be concerned with divine proportion in music? If music with healing intent is to be written with both aesthetics *and* function in mind, it is reasonable to use a form, or musical direction, that defines natural growth, expansion, beauty, proportion, and balance in nature." She continues, "Wouldn't a piece of music in a form that relates to listeners at the biological level (from molecular structure to brain functioning) as well as the perceptual level (as in visual appreciation and aesthetics) be most effective as a way to define the direction of listening, bringing the listener into balance with the basic and universal patterns of life itself? Music written using the divine proportion is bound to be of value in the field of healing music precisely because of its directional relationship to life cycles and to the forms of universal consciousness."[8]

Gardner speaks of using the proportions of the Golden Section as a compositional device. Goldman refers to the interrelationship of the ratios found in the harmonic overtone series with math, physics, and the natural sciences. They all tie in! Says Goldman, "The universe is harmonically related."[9]

It is because of the interrelatedness of harmonics (and their ratios) and so many other natural structures that harmonics are important. If we bathe the body in natural healthy sound frequencies, it can only have a beneficial effect.

SYNTHESIS AND HARMONICS

Unfortunately, electronic, digitized music loses its precious partials—the overtones of sound. It is for this reason that I moved into 100 percent acoustic sound tracks. However, a note to musicians: I suggest you pause before throwing synthesizers and samplers out the window. There are times when

you may need sounds that cannot be duplicated by live players. A case in point: while producing an album that required musical accompaniment for theta and delta zones—the slowest, most unobtrusive sound track conceivable—I wrote a piece for a full string section. It required very long single tones, some as long as three minutes before a change. At the conclusion, one of the players came into the recording booth. I thought she was going to hit me with her viola. She was so angry that she asked if I was trying to injure her.

Apparently, the combination of being late in a session when the players were already tired and the rigor of holding these extremely long tones caused her to be concerned about her own muscular damage. This was a very real complaint and possibility, and a lesson I will not forget. For the psychoacoustic effect necessary for my goal, I was asking players to do something not natural to their instruments. It was at that point that I remembered digital keyboards and samplers. No concern about muscular damage here. Although I could not get the same harmonics that I would with a real string section, the desired effect superseded the aesthetic sound. My rule of thumb in relationship to electronic and acoustic sounds: I use electronics only if they are creatively congruent or therapeutically relevant. I suggest you use acoustics whenever possible.

CONCLUSION

There are many things to consider when it comes to application-specific sound tracks. Drone, repetition, rhythm, harmony, melody, timbre, form, intent, the iso principle, harmonics, acoustics, synthesis . . . these are the basic building blocks of music regardless of the intent. But when the intent is music that informs and supports positive outcomes in human function, a different sensibility moves in.

I remember when I was a songwriter. I would have an inspiration, go into the studio, and sit at the piano, looking to find the musical phrase that fit with a snappy lyric. I knew the formula for pop music radio formats: three minutes and forty-five seconds with lots of sing-along choruses and a modulated bridge between final verses. All I needed was the key to the lock; once I found it, inspiration was complemented by craftsmanship, and the process evolved. Depending on the time of day and the graces of the creative muse, a new song would emerge in the coming hours or days.

With psychoacoustics, it is the same thing. The creative impulse still needs

to take place, and there are formulas. The major difference is that there is an additional layer of consideration. Just as a musician considers the relationship of tone, rhythm, and harmony, so a psychoacoustician thinks about the relationship of resonance, entrainment, and density. Just as a jazz player uses the extensions (ninths, elevenths, and thirteenths) beyond the major triad, a psychoacoustician considers the heart rate, breath, and brain waves.

In many cases, application-specific music can be simpler than music designed for entertainment. Simplicity is most often the order of the day. The complexity comes in the interrelationship of sound and body. Psychoacoustically, we play two instruments—that of tone and that of body.

CHAPTER 15

Sonic Neurotechnologies

The brain has been called the final frontier of the human body.[1] While organ transplants become commonplace and genetic engineering develops at quantum pace, the gray matter that occupies central headquarters is our least understood anatomical territory.

The complexity and speed of processing in the brain is staggering. Consider the following: the human brain must process millions of stimuli per second for at least four and a half hours a day to remain conscious and not fall asleep.[2] There are 100 billion neurons in the brain's frontal lobes alone. And it is common knowledge that only a small percentage of the brain mass is consciously used. Consequently, it is not surprising that higher brain efficiency is a state many seek. What may raise eyebrows, however, is the way in which this increased access, or repair, is being pursued—through the ear, skin,* and the medium of sound.

Three diverse approaches to the processing of sound frequencies hold great interest.

Filtration/gating techniques have been honed in Tomatis clinics worldwide. By gradually gating and filtering out the lower 8,000 Hz of music, and then adding the frequencies back in, a retraining of the auditory processing system occurs. The effects of filtration and gating are felt on psychological, neurodevelopmental, and physical levels.

*In medical parlance, the ear is thought of as *differentiated* skin. A famous quote of Dr. Alfred Tomatis is "The skin is differentiated ear."

Another approach to sound processing is the field of *binaural beat* frequencies. By listening through stereo headphones to slightly detuned tones (i.e., sound frequencies that differ by a small number of Hz), sonic brain-wave entrainment can take place. Facilitating a specific range of brain-wave states may assist in areas as diverse as pain reduction, sleep, enhanced creativity, or accelerated learning.

Vibroacoustics involves the application of sound frequencies directly to specific parts of the body. The applicators can be as low-tech as tuning forks or as complex as computerized frequency generators.

Representing three distinct approaches to therapeutic sound, filtration/gating, binaural beat frequencies, and vibroacoustics currently define the growing field of "sonic neurotechnologies." I have coined this phrase to describe the arena of soundwork that depends on the precise mechanical manipulation of sound waves to bring about desired changes in the psyche and physical body. As you will see, these three technologies—used in different settings—have roots in neurology, physiology, and psychology.

SOUND STIMULATION/FILTRATION AND GATING

In the broadest definition, sound stimulation can be defined as the use of auditory input to induce change in the nervous system. Sound has four elements: *frequency, amplitude, time,* and *space.* Problems with receiving and processing sonic input related to any of these elements can interfere with listening and thereby affect the quality of stimulation that the nervous system receives.

Using music as a form of organized sound, sound stimulation (*sound stim*) programs use one or more of the four sound elements to influence the ear and its direct and indirect relationships with numerous aspects of the nervous system. Benefits may ultimately enhance the listener's well-being, performance, and expression.

An element of sound that historically has been a focal point and continues to be a key component of present-day sound stim programs is *frequency (the measured vibration within a second's time; the basis of tone).* Sound stimulation typically includes a precise application of electronically processed sound—most often through headphones—retraining the ear and related systems to efficiently receive and process a full spectrum of tones.

Sheila Smith Allen, an occupational therapist and sound practitioner

whose clientele is primarily children with sensory, behavioral, and motor challenges, says, "An ear that does not receive and process tone reliably and sufficiently is a problem with considerable ramifications, whether you approach this problem from the traditional principles of Dr. Alfred Tomatis, or you consider it in relation to specific auditory processing skills, or both."

The ability to accurately process tonal input contributes to functional auditory and vestibular capabilities of the ear, as identified by Tomatis, and is a prerequisite to specific auditory processing skills. Sheila Smith Allen continues, "Receiving and processing tonal input involves a variety of factors including one's comfort with sound, and the abilities to tune-in and tune-out, discriminate, and order/sequence." This can all get quite complicated considering the complexity of tonal information involved, not only in our daily sound environments but also in just one spoken word itself!

THE NECESSITY OF HEALTHY TONAL AND SEQUENTIAL PROCESSING

As mentioned earlier in this book, Robert Doman Jr.* is a neurodevelopmental specialist. He works with children and adults who have special needs. Crisscrossing America, sometimes three hundred days a year, he evaluates clients with neurodevelopmental problems. Sound stimulation, nutrition, movement, visual-perceptual training, speech and language, and education are vital components of Doman's eclectic and highly effective treatment programs.

Language—the ability to process and use tones, phonemes, words, sentences, thoughts, and feelings—is integral to that which makes us thinking social beings. According to Doman, the neurodevelopment of language is dependent on three specific factors:

- Auditory tonal processing—the ability to differentiate among the tones used in the language
- Overall organization of the central nervous system—the establishment of hemispheric specificity and a language center
- Auditory sequential processing—the ability to link pieces of auditory information.

*Robert Doman Jr. is the founder of the National Academy for Child Development (NACD), located in Ogden, Utah.

Says Doman, "Intervention in the neurodevelopment of language involves assisting in the natural development of these critical pieces and remediation when this natural development has not occurred. In most instances, auditory tonal processing develops normally if the child is provided with good-quality auditory tonal input as afforded by an unencumbered natural environment.

"However, if the developing child is deprived of sufficient tonal input from his or her environment, the neurodevelopment of tonal processing is adversely affected. Proper development can also be stopped, or even undone, if the developing child or adult is deprived of input. Often this vital input is significantly hindered by ear infections (more specifically, fluid within the middle ear), a problem that appears to become more common every year." At any point in life, Doman asserts, "the effects of sound pollution can destroy healthy auditory tonal processing, produce hearing loss, and negate the positive neurological effects of healthy sound."*

Addressing the necessity of full-spectrum sound and healthy tonal and sequential processing, Doman participated in the compilation of eight hours of simply structured classical music. The *Sound Health Series,* coproduced by Joshua Leeds and Richard Lawrence, is a collection of multiple CDs released by ABT Music and contains rearranged, newly recorded baroque and classical music. Because of highly specific psychoacoustic refinements, this series is designed to filter out noise pollution and to enhance health, learning, and productivity. *Sound Health* is currently used in homes, schools, hospitals, psychotherapeutic clinics, and businesses in America and Europe.

Proper auditory tonal processing supports:

- A balanced and flexible auditory system—imperative for the peak performance of the central nervous system
- Auditory attentional focus—a better ability to filter out distracting background noise and focus on foreground sound
- Improved auditory sequential processing—the foundation for conceptualization and one of the building blocks of all thinking
- Receptive language skills—the ability to understand more complex language when it is heard
- Expressive language skills—the ability to speak clearly, effectively, and spontaneously.

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*"Neurodevelopmental Auditory Training: The Work of Robert J. Doman Jr." can be found online at www.ThePowerOfSound.com/Doman.

Per Doman, "As previously stated, the auditory nerve provides stimulation and organization to the entire central nervous system. A significant effect of this stimulation is to assist in the development and formation of a language center within the brain. *Sound stimulation provides positive sensory input.* This stimulation facilitates the growth of neuronal networks—the links that organize the brain."

The third factor involved in the neurodevelopment of language and thought is auditory sequential processing. Doman has found that if an individual has good auditory tonal processing and the brain is receiving good-quality input, the brain has the opportunity to learn how to put pieces together. This is auditory sequential processing.

While Doman has recognized the necessity for remediation of tonal processing problems for more than forty years, when he first became aware of the problem, he couldn't find effective treatment. "I couldn't even find anyone else who understood the problem!" he says. However, while working in Spain in the 1970s, he heard of the work of Dr. Alfred Tomatis. Doman located a physician trained by Tomatis in Madrid and was impressed with the results he observed. On returning to America, Doman began referring some of his clients to Paris to work directly with Tomatis.

It is appropriate to note a common perception that occurs independently for numerous health care practitioners: professional clinicians and educators find their methods ineffective in many cases and determine that the missing link in their work revolves around auditory function. Psychiatrist Ron Minson, educator Billie Thompson, psychologist Susan Andrews, neurodevelopmental specialist Robert Doman—each on his or her individual healer's journey—comes to the doorway of Tomatis. Each then shapes Tomatis's pioneering concepts and practices into his or her own matrix.

Tomatis created sound techniques known as *filtration* and *gating*, the primary sound applications used in the remediation of impaired tonal processing. Filtration and gating are the principal features of his invention, *the Electronic Ear.*

TOMATIS'S FILTRATION AND GATING

As examples of the use of specific sound stimulation applications, or sonic neurotechnologies, let's explore filtration and gating, both by definition and use.

Filtration means the removal of specific frequencies (tones) from an existing sound recording, be that the music of Mozart or a recording of a voice.

Through the use of sound processing equipment, it is possible to isolate and mute certain frequency bandwidths. With filtration, any part of the low, mid, or high end of a recording can be withdrawn and reintroduced at will. On a visual level, imagine erasing a part of a picture and then eventually drawing it back in. This is filtration.

When certain frequencies are removed, the remaining frequencies are accentuated or more evident. Consequently, filtering frequencies is a means of simplifying the *tonal picture* and emphasizing the remaining tones/frequencies of sound. Enhancing certain ranges (i.e., low, middle, high) is thought to positively impact the functions that Tomatis associated with those frequencies. Ultimately, a systematic progression of filtered music has been found to help the ear more actively and efficiently connect with the spectrum of sound, helping support our basic body awareness, self-regulation, coordination, and communication.

Tomatis: Frequency and Function

Low frequencies: *Body*

- Body awareness
- Rhythm
- Balance
- Organization of left/right-side function
- Muscle tone
- Coordination of posture and movement

Midrange frequencies: *Language*

- Attention
- Concentration
- Memory
- Speech and language
- Vocal control

High frequencies: *Creativity*

- Energy and alertness
- Intuition
- Ideas
- Improved speaking
- Communication enhancement
- Awakens the listening process

Gating refers to the creation of a random sonic event. In the original Electronic Ear, gating was an electronic process activated by the amplitude or high-frequency content of the music and voice.[3] Basically, the music unexpectedly jumps between the high and low frequencies.[4]

While not always pretty to listen to, the net effect of this sound treatment is an extensive exercising of the muscles of the middle ear.
The effects of gating:

- Promotes active listening
- Retrains muscles of the middle ear

The significance of these muscles:

- Important in the process of conducting sound
- Protection of the ear from loud sounds
- Amplification of soft sounds
- Accurate perception of sound

The combined process of filtration and gating creates a powerful auditory workout.[5] And for good reason! The middle ear mechanism must work very hard to translate the complexity of the "treated" incoming sound.

ThePowerOfSound.com/HistoryofFiltration/Gating (F/G)

Filtration and Gating in the Traditional Tomatis Practice

What actually takes place with the filtration/gating of sound in traditional Tomatis practice? For the answer to this question in 2000, I turned to Denver-based Tomatis practitioner Ron Minson, M.D.* After traditional medical and psychiatric practice, Minson was certified by Tomatis and reemerged as a highly qualified sound therapist. Applying ten years of clinical experience with filtration and gating at the Center for InnerChange, Minson became the leading F/G designer for the Listening Program Original Kit[6] and then went on to develop his own version of the Electronic Ear, *Dynamic Listening Systems.*[7]

According to Minson, the purpose of gating was originally to exercise the

*Dr. Minson (along with Joshua Leeds) was part of the Advanced Brain Technologies (ABT) team that created the original Listening Program kit, circa 1997. This original program is no longer in use, having been replaced by updated and improved Listening Programs (www.AdvancedBrain.com).

muscles of the middle ear, but it was also found that this random, unexpected event promoted *active* listening. "The exercising of the muscles of the middle ear in a scientific and precise manner is important in the reeducation of the ear, especially following ear infections, premature birth, allergies, or any event that may have delayed the development of listening and language. The proper functioning of the middle ear muscles is essential to protecting the ear from excessively loud sounds, for filtering out background noises, for focusing on foreground conversation, and also to facilitate the easy and fluid expression of language." Current views expand on Tomatis's notion, advocating for gating's influence on the entire middle ear system, rather than simply on the middle ear muscles themselves.

Minson concludes, "In our environment we are bombarded by noise-polluting, low frequency sounds of machines, autos, and more. They are low frequency, energy-depleting sounds that make one tired and irritable. To make matters worse, we are subjected to penetrating, very high frequency tones that are used as warnings, setting off our internal alarms, flooding our nervous system with adrenal hormones (adrenaline, norepinephrine, cortisol) that push us into a stressed fight/flight response. This includes the sirens, horns, fire alarms, and smoke detectors that pollute our environment to the point where we stop listening in order to survive. The perception of high frequency sounds needs to be retrained."

Through a gradual process of filtering out low frequencies, the ear becomes aware of what to listen for and is trained to grasp and "feel" the rich, high tones that nourish us. "I have observed in listeners a marked increase in mental and physical energy," says Minson.

"With this increased energy and motivation there is a accompanying decrease in irritability and depressed mood. Clients often report that their dreams are more active, that they feel more creative and have the ability to realize their desires. While they appear more awake and energized, their thinking is definitely more clear."

Usages and Applications

- *Primary usages.* As discussed in previous chapters, sound stimulation auditory training has multiple applications, ranging from remediation and therapeutic intervention to support of peak performance for creators, musicians, athletes, and others. While one can only imagine the benefits the general public could reap from sound stim, to date this work has been most frequently used as a tool for intervention with

people with sensory dysfunctions (including auditory processing disorder), autism, learning disabilities (attention-deficit disorder, attention-deficit hyperactivity disorder, dyslexia), communication problems, anxiety, depression, sleep disorders, brain injury, post-traumatic stress disorder, substance abuse, weakened immune function, chronic pain, stuttering, and even tinnitus. Enhanced musicality, for both musicians and nonmusicians, is also a reason people seek out sound stim trainings.

- *Therapeutic applications.* The Tomatis Method is most often an in-clinic therapeutic model. Sound stimulation is administered intensively for three phases, separated by *integration* breaks, over a period of a few months. Filtration goes as high as 8,000 Hz, and sound is delivered through headphones with bone and air conduction. Active and passive participation by the client is monitored by trained personnel. With the advent of at-home Tomatis derivatives, F/G is generally not as intensive, they may or may not include enhanced bone conduction, and sessions usually continue for a longer duration. Monitoring by a trained professional is needed for work done outside of the clinical setting.
- *Training.* Sound stim coursework is fully available for health care providers, professional educators, and musicians. Currently, numerous organizations present trainings. In several cases, including the Tomatis Method, the Listening Fitness Trainer (LiFT), and The Listening Program (TLP), a certification process is involved.

RECENT RESEARCH

The efficacy of F/G has been proven more in empirical result than in independent scientific research. Over the last fifty years, Tomatis's method of sonic stimulation has been tested on well over a million clients worldwide.[8] However, research lags the growth rate of the field. Leading Tomatis advocates are scientifically oriented, highly credentialed, and well-spoken. They will confidently share the wealth of results they have personally witnessed from sound stimulation auditory training. Yet the exact understanding as to why "scratchy" Mozart has worked miracles seems to be not so easy to articulate.

According to Dr. Billie Thompson, "The demand for more sound-based services in the United States is growing as individuals recognize that these

methods offer a new solution for disabilities and deficits that have heretofore resisted change or been untreatable."[9] However, lack of funded research to prove efficacy has hindered the outreach of these clinically proved therapeutic models. The biggest casualty of all is that many learning disabilities, not to mention numerous other tonal processing considerations, would become successfully addressed with the widespread distribution of F/G methodologies to school systems, prisons, and clinics. However, because of the web of government regulation, insurance considerations, and competing pharmaceutical interests, sound stimulation therapies will have to go through the onerous process of public acceptance.[10] The loss is to numerous people who could be helped in the meantime.

The work of Tomatis has been controversial from inception. His theories and techniques seem to ignite strong feelings one way or the other. Research into the Tomatis Method engenders mixed reviews, as well. Depending on the outcomes, some would argue that studies were not set up correctly or that Tomatis programs were inappropriately administered.

For an updated list of Tomatiswork research, devices, companies, and training, see ThePowerOfSound.com/Tomatis

Dr. Alfred Tomatis developed his filtration/gating techniques to improve listening skills and tone the ear. He determined that beyond listening and balance, the auditory function also serves as a major integrator for the nervous system as well. Looking at his foundational theories and practices, this is a man who has left a footprint of substance. He provided a blueprint of human potential with the auditory function central to balance, on all levels. Moving into the twenty-first century, the work of Tomatis continues to evolve, with new sensory combinations and high-tech distribution systems. This author continues to believe that Tomatis is evolutionary in concept and practice. If there was a posthumous Nobel prize, this man should be on the short list.

The author gratefully acknowledges and thanks occupational therapist Sheila Smith Allen for her untiring input, edits, and suggestions found within this revised Tomatis section. As a seasoned sound practitioner, Allen has "boots-on-the-ground" clinical experience with sound stim and brings a sophisticated perspective to this ever-evolving therapeutic modality.

BINAURAL BEAT FREQUENCIES (BBFs)

The term *binaural beat frequencies* describes a neuroacoustical phenomenon that takes place when the brain perceives one tone in one ear with a slightly detuned tone in the other. As a means of measuring the difference between these two tones, the brain creates a third "phantom" tone, unheard elsewhere. This is known as a binaural (two-ears) auditory beat.

Whereas filtration is the process of subtracting specific sonic frequencies from a sound track, creating the BBF effect is an additive process. Detuned sine-wave tones are mixed into a sound track of music, nature, or white noise. Sometimes the two tones can be heard; other times they can't. This is a subjective decision on the part of the producer. For the greatest effect, headphones or stereo speakers placed in proximity to each ear are recommended.

The phenomenon known as binaural beats was discovered by the German researcher H. W. Dove in 1839. He found that binaural beating (an actual *wah-wah* effect similar to vibrato) took place when separate frequencies were introduced into each ear, for example, a tone of 100 Hz in the right ear and a tone of 108 Hz in the left. The brain strives to bridge the gap by creating a third tone that is the actual difference between the two—in this example, 8 Hz.

According to the biophysics authority Dr. Gerald Oster, the binaural beat exists only as a consequence of the interaction of auditory signals occurring within the brain.[11] The sound of the binaural beat will only be heard with the participation of both ears. If one ear is covered and only one tone is heard, the brain will use normal auditory measurement senses to determine tone, amplitude, timbre, and so on. The phenomenon of BBFs is a consequence of measurement.

This natural process of sonic measurement takes place not only in humans but in other animals as well. Simply put, as a sound wave passes around the skull, each ear gets a different portion of the wave. When the wavelength of a sound signal is longer than the diameter of the skull, the brain hears the inputs from the ears as out of phase with each other. Binaural beat expert F. Holmes Atwater states, "It is this innate ability of the brain to detect phase differences between the ears that enables the perception of binaural beats."[12]

BBFs can only be heard when the tones used to produce them are of low pitch.[13]Binaural beats are best perceived when the carrier frequency (the tone in each ear) is about 440 Hz. [14]

Oster explains that above that frequency the "beats" become less distinct, and above 1,500 Hz they vanish altogether. On the lower end of the scale—below 90 Hz—the beats become confused with the tones used to produce them. In layman's terms, this means that when two slightly detuned notes in the range between the second F on the piano and the sixth G (third G above middle C) are sounded, the BBF effect will take place. Beyond these ranges, other auditory mechanisms measure the difference between two or more presenting tones.

The question arises: can this process be harnessed for psychoacoustic applications? The answer is yes. Let's explore two major by-products of BBFs: whole-brain synchrony and sonic brain-wave entrainment.

Whole-Brain Synchrony

In order for the brain to decipher the difference between two tones, the superior olivary nuclei in the brainstem create the electrical signal of measurement. The by-product of this response is known as whole-brain synchrony—a natural brain state that occurs occasionally, and momentarily, throughout the day. At these times of bilateral hemispheric synchronization, coherent brainpower is at its height. According to speech-language pathologist Suzanne Evans Morris, "When there is synchronization in brain frequencies in the same area of both hemispheres, it is much easier for information transfer to occur on the two sides of the brain, probably as a result of the entrainment itself. This simply makes us more efficient and able to deal with information in an easier way."

However, this idyllic mind state, referred to at its maximal effect as the "AHA!" or "Eureka" state, is not accessible on command. But with the application of specific audio tones to each ear, access to this prime state of awareness is increased. Says Morris, "If we can increase and control the amount of time that we spend in a synchronized state we simply function more harmoniously."[15]

The cerebral hemispheres, commonly referred to as the right and left brain, are like two separate data-processing modules; they are each complex, cognitive systems that process information both independently and in parallel. Research indicates that when the two frontal lobes of the brain are synchronized, the power of the brain is significantly increased. By using certain frequencies, one can produce a coherent and unique brain-wave state.[16] Binaural beat pioneer Robert Monroe called this state "hemispheric synchronization," or "Hemi-Sync" for short.[17]

Sonic Brain-Wave Entrainment

In addition to whole-brain synchronization, an entrainment effect can also take place. Once the third "difference" tone is created, brain waves will speed up or slow down to match the speed of the binaural beats. BBFs become a method for sonic brain-wave entrainment.

Sound researcher Michael Hutchison states, "When precisely controlled tones are combined in the brain, the olivary nucleus begins to become 'entrained' or resonate sympathetically to this 'phantom' binaural beat, like a crystal goblet vibrating in response to a pure tone. As the olivary nucleus becomes entrained, it sends signals upwards into the cerebral cortex that mix with the existing patterns of brain wave activity there to produce noticeable state changes."[18]

The electrochemical activity of the brain produces electromagnetic waveforms known as brain waves. These waveforms can be objectively measured with sensitive equipment such as the electroencephalogram (EEG). As long as one is alive, continuous electrical waves circulate throughout the brain.

Beta, alpha, theta, and delta waves pulsate at particular frequencies that are measured, just like sound waves, in cycles per second (Hz or cps). Through the use of BBF recordings, we can change brain-wave rates to states most efficient for a specific task. According to brain-wave biofeedback expert Anna Wise, we are not only in beta, alpha, or theta at any given point. Throughout the brain, a complex matrix of brain-wave states exists. However, the cortex has predominant brain-wave states corresponding to certain activities. We are alert with the fast beta brain waves, alpha waves make us daydreamy, theta waves are experienced when meditating or falling asleep, and delta is the deepest part of the sleep cycle. The cortex seems to be the primary recipient of the entraining effect of BBFs.[19]

Says Atwater, "Perceived as a fluctuating rhythm at the frequency of the difference between the two auditory inputs, binaural beats originate in the brainstem within the contralateral audio-processing regions called the superior olivary nuclei."[20] This auditory sensation is neurologically routed to the reticular formation[21] and simultaneously volume-conducted to the cortex, where it can be objectively measured as a frequency-following response.[22]

The first of three original federal patents in the field of altering brain states through sound was issued to sound researcher Robert Monroe in 1975 for the use of binaural beats in altering consciousness. Leslie France, a former coordinator of the Monroe Institute's Professional Division, says, "When a listener's environment is dominated by sounds of certain frequen-

cies, the listener tends to reproduce those frequencies within his/her own physiology."[23]

Sonic brain wave entrainment is perfectly suited to the binaural beat concept. As previously mentioned, if we put a 400-Hz tone in one ear and a 410-Hz tone in the other, the brain will hear a 10-Hz tone (in addition to the 400- and 410-Hz tones). The reticular formation insures the brain will then come to meet this 10-Hz pace and lower (or raise) the brain waves to match it. The brain's electrical pulse of 10-Hz corresponds to the alpha brain wave state. If we put a 400-Hz tone in one ear and a 415-Hz tone in the other, the brain will hear a 15-Hz tone, corresponding to a beta state.[24]

In other words, sonic brain-wave entrainment basically leads the brain, following externally created combinations and sequences of sound, into targeted arenas of consciousness—be it an alpha state or theta ramping down to delta. The binaural beats can be changed at will by changing the sound patterns. The Monroe Institute, located in Faber, Virginia, has demonstrated that methods to access different states can be learned from recordings that contain the sound frequencies that stimulate or facilitate BBFs and then recreated from memory.[25]

ROBERT A. MONROE

Current exploration of the field of binaural beat frequencies cannot take place without bringing the late Robert A. Monroe into the picture. His contributions to the field of sonic technologies, brought about through extensive research conducted by the institute he founded and funded, brought him great respect during his lifetime and continues to this day.[26]

ThePowerOfSound.com/Monroe

A New Generation of BFF Production Techniques

Hemi-Sync, the brand name of binaural frequencies produced by Monroe Products, has once again broken ground. I'd heard they'd come up with a new engineering process and was quite curious. As an experiment, I sent a very slow solo piano piece by Chopin. I'd rearranged it to include lots of pauses and long sustaining tones. I wanted to hear what Monroe's frequencies would sound like under this delicate, spacious performance. As a producer, my previous BBF experience was always good in outcome, but problematic in arrangement and orchestration. To mask the annoying motor-boat-like sounds of the BBFs, I always had to have a thick bed (pad) of sound. This

never allowed for open, delicate arrangements. What I received back from Monroe Products was remarkable! I couldn't hear the frequencies at all. This was not because the BBFs were mixed below the threshold of hearing, rather new software allowed placement of the frequencies behind each note rather the than as a broad blanket throughout.

Patrick Mooney, the Hemi-Sync production manager at Monroe Products, shares with us the following thoughts on evolving BBF technologies:

> The biggest change between 2001 and 2010 is not in the theoretical or practical framework of Hemi-Sync delivery, but in the ability to more precisely control the parameters of the technology. This is due to the continuing evolution of the computer as a digital audio workstation. What has improved are the tools available to our engineers that allow for the precise manipulation of the Hemi-Sync sound patterns in a way that wasn't possible in Robert Monroe's time. We can now create a more sonically pleasing experience for our listeners. Our mixes today are more artful and, in a sense, discreet. But we have no intention of ever leaving the work of Robert Monroe behind. There is still so much to learn about sound and human consciousness and the mysterious ways in which we find them interacting through the use of Hemi-Sync technology.
>
> The quality of the BBFs is the engineer's work. What some competitors are doing now is equivalent to what Robert Monroe was doing in the late '50s and early '60s; it is kindergarten binaural beating. At Monroe Products, we're riding a learning curve that has been fifty years in development. In the 1970s, '80s, and '90s, brain-mapping research was done in collaboration with The Monroe Institute. Having access to the patterns of specific brain wave states that Robert Monroe found particularly useful really helps us as engineers. We have good maps and know the territory . . . and as technology continues to evolve and become more affordable, we look forward to the opportunity to more precisely refining those maps. Robert Monroe certainly left with us his admirable trait of curiosity!
>
> The reason *Hemi-Sync* now sounds better behind the music is advanced equipment and knowledge. We have access to proprietary hardware and software that gives us the ability to very closely mimic brain wave patterns in their normal fluctuations. The refinement of our engineering comes with tools that allow us to "see" what we're doing on a brain wave level.

BBF Usages and Applications

Binaural beat frequencies are an ancient sonic technology. A few thousand years ago, someone inadvertantly discovered that two minutely detuned sounds create a third sound in the brain and that our brain waves slow down or speed up to match this natural third sound. The technology of modern computers now allows great precision in the application of binaural tones. The question becomes, *Which brain-wave state is most conducive to a desired activity?*

- *Primary usages.* Enhanced mental focus, accelerated learning, relaxation, meditation, sleep.
- *Therapeutic applications.* The relaxation effect associated with BBFs has been shown to reduce anesthesia use in surgery, improve motor skills in neurologically impaired children, improve response to alpha biofeedback training, enhance hypnotizability, and help to manage pain, among numerous other applications.
- *Training.* Since the first programs were made available to the public in the 1970s, BBFs have traditionally been self-administered. You buy CDs with a specific matrix of BBFs already implanted in the sound track. Right now a sizable catalog of recordings use very sophisticated programs.

  I am not aware of any current program or curriculum for BBF design or implementation, nor have I heard of anything like this in the past. For the most part, this information is quite proprietary. Knowledge of neurology, psychology, and audio engineering is very much a consideration in the design and implementation of BBFs. Aesthetics aside, creating effective frequency combinations that deal with *all* of the brain waves at the same time is a complex task. We are never in just one brain-wave state. Biofeedback experts can attest to the fact that all four brain waves are active at any given point. Effective BBF matrices must take this into consideration.

  I have occasionally seen on the market inexpensive BBF machines. These devices are essentially sine-wave generators with individual settings for stereo channels. This capacity allows you to create separate detuned sound waves for each ear, thereby setting up your own binaural beat. Given the complexity of the brain waves entrained with the BBFs, I highly recommend steering clear of this application. Health care providers and individuals are advised to use existing recordings

rather than to create their own. If you need very specialized BBF programs, I suggest you approach one of the companies listed on the website below. For a fee, they may design or create programs to your specifications.

- *Equipment needed.* CD player or digital music player (MP3) and headphones. BBFs are most effectively delivered through headphones. If this is not feasible, place speakers near each side of the head. The volume, in either case, should always be gentle.

At the 2010 juncture, there are about a half dozen American companies actively trading in the use of slightly detuned tones in each ear. Unquestionably, Robert Monroe's Hemi-Sync is the granddaddy of modern binaural beat technologies (see chapter 15). The BBF capacity to essentially *dial a brain-wave state* remains a highly effective sonic neurotechnology. The phenomenal explosion of portable digital audio players (iPods, etc.) into international culture has been very good for the BBF industry, as headphones are important for effective delivery. Now, Apple's white ear buds are a fashion statement![27] With mobile Internet devices (smart phones), millions of people now have instant access to music and sound programs and the right gear for listening right in their pockets!

Most BBF programs are widely available to the public. A standard warning is that BBF products should not be used when driving or operating heavy machinery. Likewise, people with seizure disorders are advised to have doctor clearance before use. Beyond these considerations, most BBF programs are considered *over-the-counter* sound, usable without prescription. Health care providers can train in the use of these programs with personal experience or consultation with a reputable BBF company.

For BBF resources and recent research, see ThePowerOfSound.com/BBFs

VIBROACOUSTICS

Vibroacoustics is an innovative technology in which music and sound vibrations are *felt* and sometimes *heard.* Firmly based on the principle of resonance and entrainment, vibroacoustics creates change through one vibration altering another. An impressive array of sound chairs, tables, beds (some with water), walls, and even floors (your new sonic apartment!)

are commercially available, all equipped with powerful speakers designed to vibrate the body. The United States–based Somatron Corporation began distributing designs in 1985 for use in therapeutic settings. A 1997 National Institutes of Health study featuring their sound-based furniture forms the foundation of American clinical vibroacoustic research.[28] Modern-day vibroacoustic practitioners stand on the extraordinary shoulders of Dr. Peter Guy Manners[29] (United Kingdom) and Olav Skille[30] (Norway).

Dr. Drew Pierson, a psychologist with electrical engineering experience, notes that the purpose of vibroacoustics is to create tactile-soma integration. He says, "The body holds emotional events in cellular memory. The use of vibration from 4.5–1800 Hz (primarily 8–180 Hz) has the effect of disengaging those resonant patterns that seem to run in loops and fixate themselves in the body. Vibroacoustics change the bio-electrical signature of the emotional imprint."

The application of vibroacoustic music and sound resonates the body directly through nerves, skin, and bones. Using multiple transducers built into the furniture, the sound is directed to the back, buttocks, and legs, not the ears. In fact, unless you wear headphones, the only sounds you hear with your ears are the lowest frequencies. Pierson explains that the efficiency of sonic induction through wood and metal is far greater than through air and into the ear. "The sound waves are added into the recliner via specially designed full-frequency range, steel transducers, which have been built into the structure of the recliner's frame. You become part of the sound through direct bone conduction." (See "Beethoven and Bone Conduction," chapter 17.)

Pierson became so impressed with the effect of vibroacoustics that he created his own line of sound chairs. His primary clients are health care professionals. "Professionals can use this chair for a number of modalities: sound therapy, biofeedback or neurofeedback applications—whether using binaural beats, monitoring biofeedback or neurofeedback signals, or a musical instrument." Sound chairs are extremely versatile. Audio signals from any source (CD, digital audio players, electronic instruments, or microphones) can be input directly into the chair to produce the vibrational response.

According to Pierson, the low sounds travel *up* from the vagus nerve to the reticular activating system, touching all internal organs along the way. This the reverse of how sound heard through the ear travels down through

the vagus nerve to the anus. (The vagus nerve is a very important conduit of sound waves, regardless of the direction.) While Pierson emphasizes the power of bone conduction, others consider skin absorption of sound equally important.

Whole-body acoustic stimulation has been studied by Dr. Patrick Flannigan for more than thirty years. He believes that the human skin is a powerful sense organ: "Our skin is not just a covering; it is an enormously sensitive organ with hundreds of thousands of receptors for temperature and vibrotactile input. Every organ of perception develops ontologically and phytogenetically out of skin. In the embryo, skin folds and then forms our eyes and ears. Our skin may contain the latent capacity to perceive light and sound. I think that by stimulating the skin with energy in the right way, you can potentially repolarize the brain and charge it with energy." [31]

In a program evaluation conducted at the Clinical Center of the National Institutes of Health in 1997 titled "Effects of Vibroacoustic Music on Symptom Reduction in Hospitalized Patients," Dr. George Patrick reports, "We have seen statistically significant and clinically significant results in both tension-anxiety reduction as well as symptom reduction." The goal of the project was to determine the effectiveness of Vibroacoustic Music in providing the relaxation response as an antidote to the stress of treatment and adjustment to the possibility of chronic or life-threatening conditions. Diagnostic groups included all chronic disease processes, such as cancer, AIDS, and heart, lung, blood, and psychiatric disorders. Data were gathered from 268 adult patients with varying diagnoses over a seventeen-month period. Cumulatively, a 53 percent reduction of symptoms following the program was reported.[32]

Sound researcher and chiropractor Jeffrey Thompson was so impressed with the effects of vibroacoustics that he created his own sound tables and the music to go with them. In 2000, he explained why sound tables have such a powerful effect: "A huge section of the brain stem and nervous system is devoted to sensing and processing vibration. The spinal cord is composed of nerve bundles carrying different kinds of sensation such as heat and cold, pain, pressure, vibration . . ." According to Thompson, two entire columns sense vibration and take up almost the whole posterior half of the spinal cord. In the primitive portions of the brain near the stem, large areas are devoted to the processing of vibration. "When you are lying on a sound table, powerful emotional information, in the form of musical vibrations, gets processed right in the part of the brain where our most deep-seated emotional programs reside."[33]

When I spoke with Thompson again in 2010, his understanding of vibroacoustics had evolved over the last ten years.

See Jeffrey Thompson's interview at
ThePowerOfSound.com/JeffreyThompson

Given the emotional and physical effect of low bass vibrations through the skin, vibroacoustics is a valuable avenue of soundwork for mindworkers or bodyworkers. Vibroacoustic delivery systems (with or without headphones) will create a powerful experience for your patients. Prices are in the range of $1,500 to $45,000, with many models about $3,000. Many practitioners have discovered that vibroacoustics may be of as much value as chiropractic, acupuncture, and other bodywork treatments. For ultimate efficiency with this modality, your choice of sound sources is also very important. Most people work with previously recorded music or sound frequencies. However, SaraJane Williams, one highly innovative vibroacoustics practitioner, uses a concert harp!

CONCLUSION

With the combined tools of sonic brain wave entrainment and resonance, sound waves are able to modulate brain waves through the use of binaural beats. Now, one can determine that an afternoon spent in mid-beta would benefit concentration or that low alpha is best for deep stress reduction.

As the authors of the vigilance and performance studies noted, "Only the most recent studies include sufficient experimental controls and can be considered as scientific investigations. Even so, the value of potential applications of a technology for self-control of EEG patterns and states of consciousness argues for continued investigation of the binaural beat phenomenon and its psychophysiological effects."[34]

The versatility and potential for BBF technology is impressive. Beyond all claims, personal experience is the true arbiter. Over the past few decades, I've extensively partaken of this technology. Recordings that contain BBFs have been of great value in stress reduction and deep rest. My most regular use of BBFs is for increased concentration and focus.

Filtration and gating techniques were originally created for physiological and psychological interventions. However, pragmatic applications are emerging as well. Tomatis found that he could accelerate the learning of foreign languages by training the ear to hear language-specific frequency ranges. The

"Japanese ear" is different from the "American ear." Hence the Japanese difficulty with the "r" sound. Per Tomatis, if you can't hear it, you can't say it.

Since the passing of Tomatis in 2001, exploration of his concepts and delivery methods has accelerated. In America, there are only about twenty-five people who had the honor of being trained by the master. However, as F/G techniques have evolved, so too have the possibilities of interweaving with other therapeutic or educational modalities. Innovation is a natural progression as the originators pass their creative mantles.

Robert Monroe probably never met Alfred Tomatis. There is no mention in any of their combined publications. However, if they had met, it would have been a most interesting exploration. While their methods and motivations are completely different, they are tied together inextricably through their passionate use of sound. They shared the tools of resonance, entrainment, and pattern identification. They have moved the field of soundwork immeasurably forward.

Sonic neurotechnologies must be used carefully and wisely. Vibroacoustic applications and BBF or F/G sound tracks are powerful tools. Consequently, proper consideration must always be afforded.

The therapeutic use of sound, like any new tool, requires discipline, education, and strict observance of ethical standards. There is currently no established licensure in the use of sonic neurotechnologies, though I predict that there will be in the coming years. Therefore, the onus of responsibility for handling the changes that occur as a consequence of the application of these methods falls clearly on the practitioner. Sound is a marvelous adjunct to an existing profession. Therapists and educators will do well in performing due diligence and acquiring proper training.

In chapter 17, *Advanced Sound Tools and Techniques,* we explore a Diagnostic Evaluation for Therapy Protocol, clinical applications of vibroacoustics—including Vibroaocustic Harp Therapy, tuning forks, sympathetic vibration and agricultural propagation—high-intensity focused ultrasound, Infratonic QGM, Cymatics, and bone conduction. You'll also find explorations of the Bonny Method of Guided Imagery and Music, Neurologic Music Therapy/Rhythmic Auditory Stimulation, Rhythmic Entrainment Intervention, ReSet, Brain Music Therapy, the Center for Neuroacoustic Research, Tinnitus Treatments—2010 Update, and much more!

CHAPTER 16

Applied Psychoacoustics for Health Care Practitioners

Soundwork is a natural complement to other treatment processes. Music and sound have a wide range of therapeutic applications. A case in point: music can be a superficial balm, calming the nerves of anxious patients in a waiting or treatment room. In the surgical theater, however, music has a much stronger effect. In a UK study, specific music programs significantly reduced the quantity of anesthesia needed.[1] Music and sound can be a simple adjunct to or a central structure in the architecture of your practice.

Some of you are medical practitioners; others look at soundwork from a psychotherapeutic vantage point. Some readers work with modalities falling under the rubric of holistic healing. My goal in this chapter is to help you understand how soundwork can be added to your practice. You will find simple and elementary suggestions, universal in their application. Likewise, a review of highly sophisticated soundworking techniques is presented. I also provide an overview of advanced techniques—each by itself worthy of a book. References and resources will be abundant. Consider me a guide, showing you where to explore sound techniques in the in-depth manner required by professional health care and education practitioners.

Before proceeding, a disclaimer is apropos: I am neither a therapist nor a health professional. I am a musician, record producer, and sound researcher. The information I offer is based on my cocreative experiences as a psychoacoustic producer with health care providers of many stripes. I have developed programs with medical doctors, psychiatrists, neurodevelopmental specialists, and biofeedback experts. In the collaborative process and follow-up, I've had the privilege of observing how sound programs are employed in various practices. Consequently, the greatest service I can render to the educator or health care practitioner (HCP) comes from my knowledge of sound and how it is being used. I will not be providing sonic prescriptions but, rather, reasserting basic concepts for your consideration. Consider this chapter an overview of soundworking possibilities. Adapting this information to your specific health or education modalities is in your hands.

Recommended Reading

If you are just beginning your exploration into the therapeutic applications of sound, a good starting place is to look at how others are using sound. The following books are an excellent introduction to the various facets of sound and how other professionals use them. For complete information on each, see the bibliography.

- *Listening for Wellness* by Pierre Sollier (intro to Tomatis Method)
- *Music: Physician for Times to Come* by Don Campbell (varied approaches)
- *Soundtracks for Learning* by Chris Boyd Brewer (music in the classroom)
- *This is Your Brain on Music* by Daniel J. Levitin (music neuroscience)
- *The Yoga of Sound* by Russill Paul (sacred practices of mantra)

WHAT CAN SOUNDWORK BRING TO MY PRACTICE?

Depending on your practice—health care, psychotherapy, bodywork, education—sound can complement your work in any number of ways. The following five vignettes illustrate how a chiropractor, psychotherapist, bodyworker, anesthesiologist, and psychiatrist integrated soundwork into their respective practices.

Jeffrey Thompson, a chiropractor, discovered that he could adjust subluxations painlessly and more effectively with sound than with his physical manipulations. He has since become one of the leading sound researchers in America. His work includes the development of sound products and sound tables and the invention of equipment used to decipher NASA sound recordings. Thompson is currently founder and director of the Center for NeuroAcoustic Research.

Molly Scott found soundwork so effective in her psychotherapy work that she developed a model known as Resonance Therapy. This use of music and sound has become the framework for her therapeutic practice. Scott travels internationally, teaching her innovative use of the voice in a psychotherapeutic context.

Vickie Dodd has been an Aston Patterning bodyworker for thirty-plus years. Her successful use of sound has so permeated her practice that it is now equal to the physical modalities she uses. In her book *Tuning the Blues to Gold*, she says, "Everything that has occurred in our lives is recorded in our bodies. These events are recorded in our tissue as memories that actually exude a Sound that can be engaged and integrated by our own voice. Sound is a truly powerful medium. Sound touches where hands and words cannot reach."[2]

An anesthesiologist (and former saxophone player) in Atlanta loved music so much that he brought recordings into the operating room. He found that the music not only reduced the tension of the medical teams but also calmed the patients to such a degree that his use of anesthesia was remarkably diminished. Dr. Fred Schwartz then became instrumental in recording internal womb sounds that have become a valued tool in neonatal intensive-care units throughout America and abroad.

One of my favorite stories is about Dr. Ron Minson, a psychiatrist. One of his own children was having such dire emotional problems that all Minson's years of training and practice could not positively affect her. In exasperation, he went through the Tomatis Method with his daughter. Witnessing her profound turnaround, Minson dropped everything to study in Europe with Alfred Tomatis. For many years, he was the medical director of the Center for InnerChange in Denver. Soundwork was at the heart of his clinic, augmented by attention to food allergies, nutrition, biofeedback, and neurotherapy (see Minson's interview concerning *Stress-Induced Auditory Dysfunction* at www.The PowerOfSound.com/siad).

Clearly, soundwork is infectious. Chances are that once you begin to use sound in your practice, it will naturally increase in value to you. At this point you may be considering your expensive certificate or professional license; are

you about to start chasing after your long-lost love of music instead of paying your student loans or clinic mortgage? Before you put down this chapter in fear of financial ruin, rest assured that you are in control! Like any modality, the use of soundwork comes down to frequency and dosage.

Here are just some of the ways that soundwork is currently being employed in clinics and centers around the world:

- Office and treatment room ambience
- Relaxation techniques, stress reduction, auditory biofeedback
- Pain control
- Reduction of anesthesia and medications
- Correction of tonal processing difficulty
- Abatement of hearing sensitivities
- Correction of learning disabilities
- Birthing assistance
- Musical thanatology

So how can you initially employ sound without taking significant time off to study? Start off easy. Unprocessed sound (without sonic neurotechnologies) cannot harm. The worst you can do is irritate someone, and don't worry, people will let you know. To begin, simply add sound as ambience. With proper attention to resonance (tone) and entrainment (rhythm), you can accomplish a great deal with minimal investments of time and money. It is the more sophisticated uses of sound programs, such as those using sonic neurotechnologies, that require more in-depth study.

A BRIEF REVIEW OF PSYCHOACOUSTICS

Psychoacoustics is the study of the perception of sound: how we listen, our psychological responses, and the physiological impact of music and sound on the human nervous system.

The basic ingredients of applied psychoacoustics for health and education are:

Resonance. The effect of one frequency vibrating another.

Entrainment. The process whereby internal systems speed up or slow down to match an external, periodic rhythm. (Review both resonance and entrainment in chapter 4.)

Pattern Identification. The brain's progression of analyzing sensory data, seeking a pattern, and allocating perception to an *active* or *passive* level of awareness.

Sonic neurotechnologies. Sound processing techniques that have a measured neurological impact. (See chapter 12.)

Intention. Being clear about what you want to accomplish with sound.

PSYCHOACOUSTIC CHECKLISTS

Thinking of the basic principles of psychoacoustics as checklists will help you apply them in your individual circumstances. Consider the following checklists as learning devices intended to let you view sound with a new filter.

Resonance: External Sounds (Simple Tone or Music)

Key question: *Do you want to stimulate or decrease activity?* High sounds charge the nervous system. Bass sounds discharge the system. Acoustic sounds are usually best.*

Entrainment: External Rhythms

Key question: Do you want to *arouse* or *soothe* the nervous system? Fast rhythms encourage beta brain waves. Slower rhythms encourage alpha brain waves. Very slow rhythms encourage theta and delta waves.

Pattern Identification

Key question: Do you want to encourage *active* listening or *passive* hearing? Random sonic events keep the brain looking for a pattern, whereas easily identified musical forms are quickly identified, and attention becomes habituated.

Complex sound or simple sound? Do you want to mentally stimulate (distract) the mind or create spaciousness? The density of sound, be it a four-part counterpoint or a single instrument playing out of time, can

*The harmonics of acoustic sounds stimulate the electrical fields of the body. In a healing context, I think of electronic, nonacoustic sounds as akin to iceberg lettuce—crunchy but with no nutritional value. In a healing environment, you want to feed the healthiest sounds you can to the nervous system. My rule of thumb: the only time to use electronic (synthesizer) sounds is if it is artistically congruent or therapeutically relevant. Otherwise, stay acoustic.

either arouse (and possibly tax) the nervous system or soothe and calm.

Sonic Neurotechnologies:

Key question: *What serves?* Programs with binaural beat frequencies can be used to facilitate brain-wave states conducive to a specific health-related activity, be it self-directed healing sessions, pain reduction, or sleep. Sound stimulation programs with filtration and gating are generally appropriate in the psychotherapeutic and educational arenas.

Programs including sonic neurotechnologies should be used only after careful consideration and appropriate training.

To see psychoacoustic checklists, go to ThePowerOfSound.com/Checklists

These examples should help you see a simple checklist for sonic assessment. Your primary questions should be: *What is called for and needed? What does the client prefer? What are my tools?*

In sound, everything keeps coming around to resonance and entrainment. All the tools—special recordings, vibroacoustic sound tables, filtration devices—are based on the psychological and physiological effects of resonance and entrainment. (If you have questions about these two basic concepts, revisit part 1.) Even the simplest concept has a layer of complexity. In whatever ways you need to perceive and mentally file resonance and entrainment, I urge you to take the time to do so. These basic concepts will be the "filtering" mechanism used in your assessment of simple and advanced sound employments.

WHERE TO BEGIN? SOUND SPACE

Here are simple ways to add sound to your practice. Appropriate sound in your waiting room sets a relaxing ambience, helping soothe anxiety or jangled nerves. With the addition of *intentional* sound, your clients' perceptions of the healing experience begin the moment they walk into your office. This will become part of the sense-memory they retain. A simple stereo system with warm sound can make a world of difference. A bonus: you will see the positive effect among your staff as well.

Use separate sound systems in each treatment room. I recommend this because your patients have different needs and treatment cycles. Portable

desktop systems are of high-enough quality to suffice. The volume should always be kept low. If you can place portable speakers within a foot or two of each ear, you will see a stronger effect with material that uses binaural beat frequencies. BBFs are most effective with headphones.

When using music in the treatment room, always ask your patients what kind of music they prefer. If they don't care for your choice of musical style, it will be counterproductive. You may suggest they try something new, but remember that lacking earlids, we can't shut out unpleasant sounds. In some cases people prefer silence. In the cycle of tension and release, silence is a powerful tool. At the end of a session, build in perhaps five minutes of silence. This can create a valuable closure time.

As you add music to your practice, even on this most elementary level, you will see that it has a great impact. You are essentially enrolling a major sensory system into the healing process. You are becoming the disc jockey of that process. So gather a sound collection that you are familiar with. It can be overwhelming trying to do this all at once; I suggest beginning with music from companies that specialize in psychoacoustic sound tracks. This will make your job easier. This does not mean that you cannot use your favorite flute meditation music . . . it's just that specially designed sound tracks ensure that the music takes resonance, entrainment, and sonic neurotechnologies into account. Fortunately, there is a substantial library of programs available.

Build your sound library a few selections at a time. This is a long-term investment. Get to know your sound tracks. They are important and individual sonic tools.

See the "Sound Remedies Catalog" (p. 271). The catalog is compiled for easy accessibility and illustrates the breadth of sound programs currently available.

CHAPTER 17

Advanced Sound Tools and Techniques

The following chapter contains snapshots of inspired soundwork, vintage 2010. In this revised edition of *The Power of Sound*, I'm presenting sound techniques that have either greatly matured since 2001 (the year this book was first published) or have first come to attention since. I'm aware of compelling methodologies that are also very inspired that should be included in this chapter. However, familiarity, previous exposure, and page count have a bearing on what has been included. From my heart—and with the deepest respect—kindly pardon omissions. The following is not a definitive list of leading-edge soundwork, but rather paths that I have come across.

I define *advanced soundwork techniques* as "prescriptive sound." These highly different modalities require varying degrees of professional training. Quite often this level of sound technique moves from the realm of adjunct (or minor-level treatment) into a greater therapeutic significance. In the following pages, we'll explore the dynamic areas of vibroacoustics, guided imagery and music, Neurologic Music Therapy/rhythmic auditory stimulation, Rhythmic Entrainment Intervention, ReSet (tempo-based entrainment), Brain Music Therapy, neuroacoustic research, and leading-edge tinnitus treatments. The extraordinary and evolving work began by Alfred Tomatis (sound stimulation) and Robert Monroe (binaural beat frequencies) can be found in chapter 15, "Sonic Neurotechnologies."

To begin, I'd like to focus on the work of audiologist Dorinne Davis and the diagnostic tools she has created.

DORINNE DAVIS, MA, CCC-A, FAAA, RCTC, BARA

Diagnostic Tools

Dorinne Davis has many professionally designated letters after her name, and she has put them to very good use. Single-handedly, Davis has moved the field of sound-based therapies far forward. How? She has provided heretofore-nonexistent diagnostic tools, a basis for comparisons, and hierarchies of practical value. These processes, found in all established therapeutic disciplines, significantly move clinical soundwork toward standard therapeutic practices.

Davis begins, "A sound-based therapy uses the energy of sound with special equipment, specific programs, modified music and/or specific tones or beats—the need for which is identified with appropriate testing.

"I have designed a *Diagnostic Evaluation for Therapy Protocol (DETP),* which identifies if, when, how long, and in what order any or all of the many different sound-based therapies can be appropriately applied." She continues, "It is this test battery from which we have our great successes. I have modeled it after my *Tree of Sound Enhancement Therapy*—a developmental flow chart for the correct administration of any sound-based therapy."

In this brief exploration of Davis's substantial work, I'm most interested in the tools she has provided for sound therapy clinics. At this point, there are relatively few exclusively sound-based therapeutic centers. However, they will come into being, in part through the Davis tools. She is providing therapeutic soundwork a valuable structure.

Her combined forty-plus years as an educational and rehabilitative audiologist, her experience as a teacher, and her credentials in twenty different sound-based therapies uniquely qualify Davis to develop a model for applications of sound-based therapies. She says, "Sound-based therapy goes beyond hearing, beyond auditory processing, and beyond music. Sound-based therapy utilizes the energy of the person and supports change with the person's natural form and function by repatterning this energy."

The *Davis Model of Sound Intervention* revolves around three key points:[1]

1. There are four laws, which connect the voice, the ear, and the brain. Summarized, the voice produces what the ear hears, and the ear emits the same stressed frequencies as the voice. If one is modified,

the other changes, and the brain sends the correcting response to the body. These laws are known as the Tomatis Effect and the Davis Addendum to the Tomatis Effect.[2]

2. Every cell in the body emits and takes in sound frequencies, thereby portraying the body as one's "signature symphony of sound." If there is an "out-of-tune" frequency, the "instruments" (cells) of the body are not supporting the symphony, and the music is discordant. The out-of-tune frequencies are identified. The sound is introduced to the body, and the brain then introduces the correct frequency to the cell to "tune it up."
3. The ear is viewed as the body's global sensory processor and not just a hearing mechanism, as all of the body's senses are stimulated either directly or indirectly through the ear. Sound vibration is also processed through bone response, cell response, the nervous system, the circulatory system, and the soft tissue network of the body. The body as a whole is considered a vibrational frequency entity.

   The diagnosis of the person seeking to make change does not matter, for it is the sound energy patterns of the body that determine the possibilities for change for each individual. In other words, sound-based therapies force the evaluator and the client to focus on the energy patterns of the body, not the disability. The focus is neither medical nor educational. The disability or challenges that are helped by the therapies are as a direct result of the three key points within the underlying concepts of the process. The symptoms, disabilities, and challenges are not what are addressed. Each person is helped as an individual energy entity.

Another Davis diagnostic tool is called the *Tree of Sound Enhancement Therapy*. It can be seen as a developmental flow chart for proper sequential administration of sound-based therapies. Used in tandem with the Diagnostic Evaluation for Therapy Protocol, Davis identifies if, when, how long, and in what order different sound therapies can be appropriately applied.

Davis Addendum to the Tomatis Effect

The Tomatis Method is based on the principles established by Dr. Alfred Tomatis. The relationship of the ear and voice is defined in his three laws, the

Tomatis Effect. Recent research with BioAcoustics, a new science,* has given rise to two new laws that can be applied to the ear/voice connection. Through BioAcoustics, a time domain frequency analysis of the voice becomes a predictive, diagnostic, and preventive tool for wellness. *The spontaneous otoacoustic emissions from the ear were evaluated and compared with a frequency analysis obtained through voice analysis.* A 100-percent correlation between the stressed frequencies of the ear and voice was noted. From this research, an addendum of two new laws to the Tomatis Effect was suggested.

The Tree of Sound Enhancement Therapy, as well as further detail about the Davis Addendum to the Tomatis Effect, can be seen online.

ThePowerOfSound.com/DorinneDavis

VIBROACOUSTICS

One area that has seen great development since 2001 is the field of *vibroacoustics.* Based on resonance, vibroacoustics creates change through the direction of sound vibration to specific parts of the body. As a neurologically based approach, the application of sound and music can take many forms: precisely calibrated *tuning forks,* handheld frequency generators with specific frequency commutations, large sound structures complete with computerized output of highly specific frequencies. In this section on vibroacoustics, we will look at Vibroacoustic Harp Therapy, tuning forks, sound and seed propagation, high-intensity focused ultrasound, Infratonic QGM, Cymatics (therapeutic and images), and bone conduction.

Vibroaocustic Harp Therapy—The Work of SaraJane Williams

The great inventor and futurist Buckminster Fuller created the term *synergy,* defined as "the working together of two or more things to increased effect." Sarajane Williams, psychologist, professional harpist, author, and publisher, is an exemplar in the field of synergistic soundwork. She has over thirty-five years of experience in the healing arts as a nurse, cardiopulmonary technologist, cardiac catheterization laboratory director, and biofeedback therapist.

Williams has been experimenting and practicing with not only the

*Human BioAcoustics, as originated by Sharry Edwards, M.Ed., can be explored by going to www.soundhealthinc.com.

beautiful sounds of the harp, but the physical vibrational effect as well. The creator of Vibroacoustic Harp Therapy (VAHT), she often plays her harp in her psychology practice in conjunction with a Somatron vibrotactile chair or sound bed. When she began her work in 1990, prior to the advent of the Internet, Williams was unaware of others exploring the application of sound waves directly to the body. She later discovered the work of Olav Skille from Norway, who introduced the concept of vibroacoustic therapy (VAT) at the first International Society for Music in Medicine Symposium in March 1982.

Why vibroacoustics? Simply put, Williams says, *"This sound therapy is the medicine of the future."* This musician/healer believes VAHT is a non-pharmacological approach to treating pain, stress and anxiety, with no side effects. During her half-hour to one-hour sessions, clients generally note significant symptom reduction within the first twenty minutes. In a review of sixteen client sessions, Williams noted that pain/tension levels in all areas of the clients bodies were reduced by an average of 3 points on a subjective rating scale of 1 to 9, with legs, back and shoulders realizing the greatest amount of tension reduction. The level of receptivity of the client can affect the outcome of the session, as with most interventions. VAHT is now being offered to inpatients in the Palliative Care Unit at Hawkesbury & District General Hospital, Hawkesbury, Ontario, Canada. No controlled studies have been performed to date, and further research is needed.

VAHT case notes and resources by SaraJane Williams can be found at: ThePowerOfSound.com/Williams

John Beaulieu: BioSonic Tuning Forks

Another element of vibroacoustics comes in the compact form of tuning forks. Long used as an accurate tonal guide for tuning musical instruments, a tuning fork is a small steel instrument (approximately 3"–8" in length) with two prongs that, when struck, produce a fixed tone in perfect pitch. Used in therapeutic settings, tuning forks of precise frequency may be strategically placed directly on the body and are selected by the practitioner to correlate with physical body energy systems. In the hands of sound researcher John Beaulieu, tuning forks offer a powerful way to resonate the body, brain, and etheric fields: "Our bodies, like musical instruments, can be in tune or out

of tune. When properly tuned, we have a sense of well-being and perfect self-expression." Beaulieu has pioneered a new musical form that can tune our bodies and nervous systems, with the purpose of creating greater harmony and balance. "When we listen to the tuning forks, our vestibular system—via the semicircular canals—reproportions our body based on the natural ratios of the tuning forks. During the listening process our physical body will reposture itself in alignment with the intervals created by the tuning forks. During the process, our nervous system comes into balance via the right and left hemispheres of the brain."

Beaulieu, a board-certified naturopath and polarity practitioner, tells an interesting story about how he came to see the value of tuning forks while sitting in an anechoic chamber at New York University. (An anechoic chamber is a completely soundproof room that resembles a sensory deprivation chamber.) "I had read about the experiences of the composer and philosopher John Cage and decided to conduct a similar experiment. While in the chamber, Cage heard two sounds, one high-pitched and the other low-pitched. The engineer who was working informed him that the high sound was his nervous system and the low sound was his blood circulating."

Inspired by Cage's experience, Beaulieu sat in an anechoic chamber for five hundred hours over a period of two years and listened to the sounds of his own body. "I began to correlate different states of consciousness with the different sounds of my nervous system," he says. "Being a trained musician, I noticed that the high-pitched sounds of my nervous system consisted of several sounds in different intervals. Then one day I brought two tuning forks and tapped them. Immediately I observed that the sound of my nervous system came into resonance with the sound of the tuning forks. It was then I realized that people can be tuned like musical instruments!"[3]

According to Beaulieu, author of *Human Tuning: Sound Healing with Tuning Forks* (see the bibliography), there are two ways to use tuning forks to tune the body. One is to hold them by their stems, tap the ends lightly on your knees (or some other hard object), and then place each fork four to six inches from each ear (one tuning fork on either side of the head). You can then use your voice to harmonize with them. The second way is to strike them together gently (away from the head) to create harmonic overtones. You may also move them around your head or body in order to experience the effects of the interval they create.

As tuning forks have become increasingly popular with massage therapists and other practitioners to deepen relaxation and balance the body's energy fields, Beaulieu has developed a comprehensive product line he calls Pythagorean Tuning Forks. Numerous intervals are available based on ratios thought to have specific effects on the mind and body. Beaulieu continues to refine his work with tuning forks and the pressure points of Dr. Randolph Stone's Polarity Therapy.[4]

Fabien Maman: Tuning Forks and Acupuncture Points

An extraordinary approach to the use of tuning forks has been pioneered by Fabien Maman, founder of the Academy of Sound, Color, and Movement. Extensive trainings explore the field of vibrational medicine, qi movement, acoustic sound, and pure color. Tuning forks are an integral part of the Maman approach.

In his thirty-plus years of research, Maman has determined the exact frequency of each acupuncture Shu Point, Mu Point on the back, and Ear and Foot Reflexology Point. He uses specially designed tuning forks that resonate at these frequencies, applied to the acupuncture points of the body. As he explains in *The Body as a Harp: Sound and Acupuncture,* the tuning forks act on the physical and etheric levels (etheric acupuncture points). The tail of the tuning fork stimulates the acupuncture point itself and then the meridian. The fork vibrates the etheric body and gives the same stimulus to the etheric energy field. When used accordingly, the vibrating tuning fork balances the physical and etheric energy systems.

The vibration of sound travels faster through the tuning fork to the acupuncture point and meridian than the vibration of the needle. Because the sound also touches the etheric points, the tuning fork vibration can work to dissolve the crystallization of energy in the etheric as well as the physical level.

SYMPATHETIC VIBRATION AND AGRICULTURAL PROPAGATION

Donna Carey, L.Ac., and Ellen F. Franklin, M.A.

The Kairos Institute of Sound Healing was founded in Seattle, Washington, in 1997 and moved to northern New Mexico in 2001. The professionals there are the creators of the Acutonics System, and they have trained practitioners and teachers throughout the world. Acutonics is a system of

vibrational sound healing rooted in Oriental medicine and philosophy that uses tuning forks and symphonic gongs tuned to the planets, Tibetan bowls, bells, drums, and rattles. After years of working with sound and people, Kairos cofounder Donna Carey also brings her attention to the effect of sound frequencies on seeds. I asked the Kairos team to share what they have discovered. The following narrative is provided by Donna Carey, L.Ac., and Ellen F. Franklin, M.A.

Located at 8,500 feet in a rural community in northern New Mexico, the Kairos Institute of Sound Healing, our students and teachers have been conducting experiments in the use of sound vibration to enhance agricultural production. Our research has focused on the effects of sympathetic sound vibration and dimensional harmonics, in seed germination, plant pollination, fruit setting, and quality and quantity of fruit and vegetable production. Driven by the desire to create a sustainable future that would generate sufficient quantities of quality food to feed our community, we applied our knowledge of human physiology, meridians, planetary science, and sound vibration. Our experiments in the direct application of sound frequency to plants exceeded our wildest expectations.

Despite our New Mexico location in the southwestern portion of the United States, our elevation is equivalent to growing in the northern United States in areas like upper Minnesota. For over ten years we have had extensive outdoor gardens but impacted with a very short growing window (mid-June to early September).

In order to extend our growing season and amplify our experiments with sound, we began with the installation of a 33-foot geodesic growing-dome. It was selected for the icosahedral shape and sacred dimensions.[5] The dome has a 1200-gallon thermal mass pool, solar powered ventilation, circulation, and aeration system. The combination of the water and the dome's shape both act as powerful amplifiers for our vibratory experiments.

In our outdoor gardens in previous years, plant size was small, plant production was slow, and yield was minimal due to the harsh growing conditions and short season. This first domed year (2009), our season was equally short and harsh with less sun and little rain in July, which is a critical month for growing. In our experiments, we started our outdoor plants in the dome and applied sound vibration from specific tuning forks and hand chimes of the same frequency over the seedlings. The *outdoor harvest* was far superior to prior years!

In the dome, the plant growth was otherworldly. People who saw them wondered if we were feeding steroids. Many of the tomato plants grew 8 to 10 feet in height, squash plant leaves were over 3 feet in diameter, and both summer and winter squash and all varieties of tomatoes have been extraordinarily prolific.

Our experiments focused on the use of planetary tuning forks and chimes that are tuned to the frequency of Mars and Venus, which when combined, create a musical 5th. The frequencies we work with are derived through science and mathematics—Kepler's calculations of planetary rotations, as well as through research on the effects of planets on human physiology.[6]

Functionally, the vibrations of the tuning forks, when activated close to the flowers, generate a field that simulates the fluttering or movement of the bees. Growing plants in an indoor environment presents unique challenges in the area of pollination, biosphere management, and creating and maintaining an ecosystem in which plants can thrive, grow, and produce.

Prior to the dome, and the application of sound frequency, we were unable to produce a tomato plant that ripened or thrived. As indicated previously, our tomato plants now range in size from 8 to 10 feet in height. The plants are loaded with fruit and continue to produce exceptional tasting produce. At the end of September, every plant was still producing and flowering. In addition, because we had no expectation that everything would germinate, the plants were spaced very closely and did not receive any fertilizers throughout the season. We had nearly 100 percent germination rate on all seeds. An unexpected consequence is that the snails, and fish in the thermal mass pool, also produced record levels of progeny.[7]

Our work with sound and agriculture draws heavily on the principles of Biodynamics, understanding that the nature of a plant is in direct correspondence to the nature of a human, and that plants, planets, and humans share a deep and profound connection to the earth, where one mirrors the nature of the other.

Although we had been cautioned about the inherent problems we might encounter, our level of productivity exceeded every estimate, in size of plants, plant leaves, fruit and total harvest, and the longevity of production, although we need to conduct specific focused experiments in pest management—a significant problem with indoor growing.

All of our experiments incorporated our knowledge of Sacred Geometry, Sympathetic Vibratory Physics, and the Acutonics approach to optimal

health, which draws on the art and science of sympathetic resonance, and our profound relationship to the archetypal, mythic, and correspondent qualities of the planets.

Our experiments with plants indicate that the same basic principles can be applied to the physiology of plants. There was more than 97 percent fruit production from flowers using this technique, and many of our plants continue to flower and produce. The growing sequences and maturation of the plants were also enhanced through the use of the symphonic planetary gongs.* The application of tuning forks was a highly specific approach to enhance pollination. The gongs used represent three cycles (frequencies) of the Earth, the four seasons, the Earth spinning on its own axis, and the Earth going through its precessional cycle. The use of the gongs supported the entire agricultural process creating a sound harmonic of the earth itself in the growing dome to enhance the growth of the plants, and to establish daily, seasonal, and extended cycles.

These protocols are based on the way we work with people: 25 seconds, applied 3 times, in the field of the seeds to germinate and then over the flower of the plant to pollinate, in the way a bee would, the vibration of the tuning forks and gongs enhance pollination.

Just as humans have souls, we believe that all sentient beings, planets, and plants all have a soul. The intersection point is not just through the etheric field and plant physiology, but we reach into its soul and essence, via the water content and cell structure and membranes. Fruit and vegetables have water contents of between 75 to 95 percent. Plants, like humans and animals, also live between heaven and earth, between sun and earth, and are intermediaries of divine energy—critical messengers able to store memories of their existence in water. When we apply sound to the various stages in plant history, the seed, the flower, the fruit, we reawaken their consciousness to unite in a common goal with humanity. We are working directly and consciously with the life forces and subtle energy active in nature. The overarching aim is an alchemical transformative path that works in harmony

*We incorporated the use of three Earth gongs in the dome. The Ohm gong is representative of the Earth traveling through the seasons, the Earth Day gong, which represents Earth spinning on its own access in the 24-hour cycle, which is extremely generative, and the Zodiac Earth which represents the rotation of earth through the 25,920-year processional cycle. This cycle connects the plants to the larger cosmic forces the wisdom of the ages and the interconnecting cycles of time and space. When the Ohm Gong is sounded with the Earth Day gong it is as though we are inviting photosynthesis. These two gongs combined are an invitation to growth and greening.

with the Earth and the heavens in a way that is both healing and productive to the whole.

Our Conclusion

The use of sound vibration in the dome was highly successful. Germination, pollination, and taste of the produce exceeded all projections. Because our office and gardens are located in an ancient caldera with numerous underground springs, it is not possible to generate a double blind study where some plants receive sound vibration and some don't. Even our attempts, which focused largely on the use of sound in the dome, resulted in our outdoor gardens producing at record levels. Although many seeds were started in the dome—based on our record keeping from prior years, when sound vibration was not used—it is clear that productivity and quality of our produce has been greatly enhanced through the application of sound, even given the distance between the dome and our outside gardens. We believe there is tremendous potential to improve the yield, quality of produce, and pest management through the applications of sound. This may well be the future of agriculture. One of our students, experimenting with sound and wine production in Napa Valley, California, is also having exceptional results. We hope to identify other opportunities to directly compare productivity differences between plants that receive sound frequency and those that don't.

When you consider the beneficial use and application of sound frequency to agriculture, it is clear that future use of intentional sound vibration has enormous potential in all aspects of human and planetary health.

As mentioned, these excerpts are printed with the kind permission of the authors, Donna Carey and Ellen F. Franklin. Due to space limitations, many valuable and insightful explorations were omitted. I encourage the reading of the full essay online at:

ThePowerOfSound.com/Gardening

You will also find a related 2004 research study, "Measuring Effects of Music, Noise, and Healing Energy Using Seed Germination Bioassay."

For a list of tuning fork resources, see ThePowerOfSound.com/TuningForks.

HIGH-INTENSITY FOCUSED ULTRASOUND (HIFU)

Traditional medicine has long used *ultrasound,* a common means of imaging, for measurement. The production of ultrasound can be used to penetrate a medium and measure a reflection signature. This *signature* reveals details about the inner structure of the medium.[8] First introduced to the medical world in the 1960s, ultrasound has recently become the second most widely used diagnostic imaging modality, eclipsed recently by magnetic resonance imaging (MRI) technology. However, the use of ultrasound is moving beyond diagnostic imaging.

Therapeutic ultrasound can be described as a controlled sound wave intended for biological interaction for a curative benefit.[9] This therapeutic use of ultrasound has advanced primarily because of MRI precision. MRI has been in use to locate tumors since 1983. What is new is the combining of ultrasound with MRI. *High-intensity focused ultrasound (HIFU)* is becoming a modern medical technique. After MRI technology is employed to locate the tumor, ultrasound waves are then used to heat the tissue and disintegrate the mass.

In the United States, HIFU applications are still limited. Since 2004, HIFU has been used only to treat uterine fibroids. In Europe, however, HIFU is being used for prostate cancer. A 2009 HIFU clinical study in two London hospitals had significant results; of 172 men with prostate cancer who were treated with HIFU, the follow-up of 159 subjects showed 92 percent to be cancer free a year later.[10]

Also in 2009, Swiss researchers found HIFU to be a preferable alternative to invasive brain surgery.[11] In a fast and painless procedure, select patients went into a modified MRI with built-in ultrasound emitters. The researchers obtained results similar to conventional methods of radiofrequency ablation. More study is needed, but the researchers believe that in the future, HIFU will be a common treatment for many types of tumors and other related maladies.

Lithotripsy refers to the medical usage of resonant frequencies, a technique used in American hospitals since 1980. Acoustic shock waves, generated outside the body, are focused onto a kidney stone in the kidney or ureter, causing the stone to fragment. In 2000, more than two thousand lithotripters were in operation around the world, and some five million treatments had been given. Approximately 70 percent of patients receive lithotripsy in

conjunction with some other procedure. Thus, open surgery can be avoided in 95 percent of kidney stone cases. The procedure is used for the removal of pancreatic duct stones as well.[12]

In America, the employment of frequencies to modulate the body—outside of the institutional uses previously mentioned—has been considered alternative and *illegal* medicine. Under U.S. Food and Drug Administration (FDA) jurisdiction, certain sound (frequency)-oriented devices have been banned and confiscated in the past. These have included *Radionics* devices and the Audiokinetron. Currently, however, sound devices and accompanying techniques are being used, and in some cases, certified by the FDA. Infratonic QGM and Cymatherapy are two of note.

INFRATONIC QGM

Infrasound is a frequency lower than the normal range of human hearing, (i.e., below 20 Hz). The primary organ for *sensing* (not hearing) infrasound is the ear. However, when infrasound vibrations are broadcast at high levels, they can be felt in various parts of the body.

Infrasonics is the study of low-frequency sounds, ranging from 20 Hz down to 0.001 Hz. The scientific use of infrasound includes charting rock and petroleum formations below the earth, the monitoring of earthquakes, and also ballistocardiography and seismocardiography (to study the mechanics of the heart). Many large animals use infrasound for communication, including elephants, hippos, rhinos, giraffes, and alligators. The infrasound waves produced by whales are used to communicate up to hundreds of miles.

When a senior scientist at Beijing's National Electro Acoustics Laboratory discovered that qi gong masters emitted high levels of infrasonic waves (also called secondary sound) from their hands, she became intrigued. Lu Yan Fang found a way to simulate this *infratonic* sound with a machine. Tests on 1,100 hospitalized patients produced impressive results. Fang found that therapeutic benefits included headache relief, pain reduction, muscular relaxation, increased circulation, increased production of alpha waves in the brain, and alleviation of depression.

In China, Fang's Infratonic QGM is widely used as an effective tool for pain alleviation. Her work has been recognized by both the China Ministry

of Health and the National Committee for traditional Chinese medicine.[13]

In the United States, Fang's Infratonic explorations have evolved into Infratonic Sound Therapy. The Infratronic 8000 Therapeutic Massager is a device that combines eight ultra-low-frequency sound waves designed to "penetrate superficial and deep layers of the body to dissolve cellular trauma of all kinds." Registered with the FDA as a low-frequency, electro-acoustical therapeutic massager, this $800 frequency generator is designed for treatment of pain and accelerated recovery. Product information states that Infratonics activates local tissue by increasing the circulation of blood and lymph, moving old fluids out of painful areas and drawing in fresh, oxygenated fluids to enhance the healing process, reduce swelling, and relax muscles.[14]

Infrasound waves are characterized by their ability to cover long distances and get around obstacles with little dissipation. Elephants produce infrasound waves that travel through solid ground. Using their feet as receptors, other herds sense the vibration hundreds of miles away.[15] To be able to harness the frequency energy that can travel through earth and ocean for use within the human body is amazing. That it was inspired by the scientific discovery of the vibration emitted by qi gong masters is nothing less than jaw dropping!

CYMATICS

The term *Cymatics* (pronounced sigh-matt-ix) derives from the Greek word *Kyma,* "matters pertaining to waves (periodicity or cycles)." Building on the work of Ernst Chladni (1756–1827), Dr. Hans Jenny (1904–1972) visibly demonstrated the organizing power of sound and vibration with breathtaking photographs and films of particles and liquids responding to vibrations. Following the legacy of Chladni and Jenny, extraordinary work continues by John Reid (United Kingdom) Erik Larson (United States),[16] and Alexander Lauterwasser (Germany)[17] to visibly capture the effect of sound, voice, and music on liquids and substances. The image on the cover of this book is a cymatic representation of a 22.2-Hz sine wave, photographed by Erik Larson.

Interest has branched into two areas: the therapeutic applications and the visual portrayal of specific frequencies.

CYMATHERAPY

Dr. Peter Guy Manners worked in the 1940s with scientists and medical doctors researching the biosignatures* of the human body. After decades of trial and error, Manners and his group succeeded in developing more than seven hundred commutations,† precise combinations of sound frequencies for application to the body and found to promote healthy tissue and organ systems. In the 1960s, Manners conceived of the world's first sound therapy instruments. This development marked the birth of Cymatic Therapy, or Cymstherapy, the therapeutic application of sound and magnetic energy. In Cymatic Therapy, a computerized instrument transmits resonant frequencies of sound into the body. Unlike other sound therapy devices, audible sounds are sent directly through the skin, not into the auditory canal. Manners asserted that his device and therapy use sound waves within the audible range to stimulate immune and physical regulatory systems, producing a near-optimal metabolic state for a particular cell or organ.[18]

Manners, who passed away in August 2009, maintained that frequencies passing through healthy tissues reestablish healthy resonance in unhealthy tissues. "Every object, whether inanimate or alive, possesses a unique electromagnetic field that exhibits antagonistic, complementary (resonant), or neutral reactions when it interacts with other electromagnetic fields," said Manners. By transmitting precision sound frequencies into specific parts of the body, Cymatic Therapy establishes equilibrium.

Manners passed the baton of his life's work to Mandara Cromwell, a young woman from Atlanta, Georgia. From that has evolved Cyma Technologies International and FDA approval of sound frequency devices. The evolution of Cymatic Therapy is emblematic of the maturation of the field of soundwork.

In 2001, Cromwell, an American marketing consultant for integrative health care products, met Manners, a British osteopath, and began a journey that has led Cymatic Therapy to the leading edge of developments in sound therapy and healing in the present day.

Building on the principles and research of Manners, Cromwell founded Atlanta-based Cyma Technologies International in 2002. Cyma Technologies

*Per Manners, each cell has its own "biological signal that is resonant with nature" to perform its special purpose in maintaining balance and harmony in the body.

†Manners called the frequency programs he formulated *commutations.* Each commutation consists of five combined acoustic sound frequencies directed to specific parts of the body.

continues the research and development of Cymatic Therapy instruments, which combine sound and magnetics to support the body's natural self-healing abilities.

Per Cromwell, "Dr. Manners gave me approximately 750 commutations (five frequencies each) for specific tissues and organs. At this time we are researching the efficacy of these frequencies and not introducing any new ones. After we research the effectiveness of these programs, we will then begin to refine and research other frequency combinations." Cromwell says Cyma instruments do not diagnose or currently have an evaluative component. She points out, "Only a medical doctor can diagnose. Instruments, devices, machines only evaluate or assess."

The study of the effects of sound, light, and magnetic frequencies on organs and muscle groups continues to build on the fifty years of Manners' research. Cyma Technologies works with integrative medical offices and their patients using MRI, x-ray, diagnostic ultrasound, thermography, as well as blood tests to track the success of Cyma commutation protocols.

Current research demonstrates positive results, including pain relief and tissue regeneration in torn tendon repairs and bone fractures, increased perfusion in fibrotic scar tissue, and preliminary success with autism.

CYMA DEVICES

In 2005, the Cyma1000 was released. Per the company website, this basic Cymatic Therapy unit supports and balances the resonant frequencies of various types of tissues and can be used to address a variety of imbalances in the body. The Cyma1000 includes over five hundred different commutations designed to support specific tissues and organ systems. Magnetics has been added to the application of sound frequencies. Many medical studies have proven that oscillating magnetic fields are effective in treating physical problems. The Cyma applicator, or wand, contains a static magnet seated in the diaphragm of the applicator head, which oscillates at the same frequency as the sound wave. The combination of sound and magnetics—two powerful and natural restorative agents—enhances results. Current users include medical doctors, osteopaths, acupuncturists, chiropractors, massage therapists, and other complementary practitioners.

In 2010, the CymaLumiere premieres. For the first time a sophisticated, user-friendly Cymatic Therapy device will be affordable to most households. Representing the latest in cutting-edge technology, the CymaLumiere

harnesses the power of sound, light, and magnetics in a handheld device.

An interesting adaptation of Cymatic Therapy is the use of applied frequencies with horses.[19] The creators of *Cyma Equine Bioresonance Therapy* have mapped thousands of sound-vibration spectrums found throughout the horse. When the animal is diagnosed with an ailment, the Cyma1000E is programmed according to the particular condition, and the affected area on the animal receives sound vibrations. In use since 2003, racehorse trainers and amateur equestrians alike attest to the efficacy of this advanced bioresonance therapy; many common equine injuries are healed in a fraction of the time normally required. In some cases, recovery has been achieved through this treatment as a last resort.

Cymatic Therapy continues to evolve, with plans for instruments that combine sound vibration with *radiant solar energy* frequencies (to enhance intercellular communication) and an instrument that combines sound vibration with *low-intensity laser light* (to facilitate precise application and deep penetration of radiant energy).

Cymatherapy has made a major contribution to the field by bringing therapeutic soundwork closer to medical establishment acceptance. The Cyma1000 device has been approved by the FDA as a physical medicine therapeutic device, defined as "an electrically powered device intended for medical purposes, such as to relieve minor muscle aches and pains (therapeutic massager). The Cymatics methodology now joins the very exclusive ranks of FDA-sanctioned applications of sound, ultrasound, and lithrotripsy,* a major step forward in the field of therapeutic soundwork.

TPOS Mandara Cromwell interview:
ThePowerOfSound.com/Cyma

Within this inspiring and thought-provoking dialog, questions range from Manner's biosignatures and commutations to FDA process and the future of Soundwork.

OF CYMASCOPES, CYMAGLYPHS, AND SOUND

British inventor John Stuart Reid[20] is a Cymatic researcher who studies the patterns manifested by sound when applied to liquids or loose particles. In

Lithotripsy is a medical usage of resonant frequencies whereby acoustic waves, generated outside the body, are focused onto a body organ to effect change. See page 211.

collaboration with design engineer Erik Larson, Reid created an extraordinary instrument called the *CymaScope* (see frontispiece). As with Hans Jenny's *tonoscope,* the CymaScope reveals sound wave patterns by exciting sand or other loose media spread on a thin, flexible membrane to which sound is applied. The technique also works well when applied to water or other liquids. An extraordinary and beautiful image produced with the CymaScope, known as a CymaGlyph, is seen on the cover of this book—a 22.2 Hz sine wave.

Reid's years of studying the beautiful images derived from sine-wave tones, human and animal sounds, music, planetary sounds, and more has opened a unique window on the visual world of sound. Looking out that window, I asked him what were his most interesting sound-oriented breakthroughs between 2001 and 2010? His thought-provoking insights, in his own words, are listed here:

a. **Audible sounds** are spheroid in form. The model of sound as a wave, traversing space in two dimensions, like waves on a pond, is inaccurate. Sound propagation is almost perfectly spherical. This principle has been known for over a hundred years, however by using the outdated wave model we close our minds to important phenomena related to sound's true, spherical nature. Updating our understanding of the true nature of sound propagation, as an oscillating spheroid pattern, will avoid the risk of drawing false conclusions based on an outdated model, as I will demonstrate in our forthcoming book on cymatics, entitled *Universe in a Drop of Water: The Secret World of Visible Sound,* which is to be published in 2011.
b. **Micro cymatics** is the study of sound made visible in the microscopic realm. Sound naturally manifests on the surface tension of any membrane. Using a child's balloon for example, when we gently hold its latex surface and speak, we can feel the balloon resonate; sound vibrations are actually forming a beautiful pattern on the balloon's surface, though we cannot see it because the oscillating wave patterns are so small. CymaScope technology allows us to see such sound patterns.

   Likewise, imagine a microscopic bubble. A pattern will be present on the surface of the bubble, modulated by the surface tension on the surface membrane of the tiny bubble. As a fingerprint on glass can be made visible by using a dusting powder, we can make the sound

pattern visible on the surface of microscopic bubbles using special lighting techniques. Micro cymatic technique is an important development allowing us to see sound patterns on living cell membranes, revealing important clues to healthy cell division, and how sound may promote health.

c. **Sound and electromagnetics.** It is now generally believed that cells communicate with their immediate neighbors via infrared electromagnetism. *I have theorized that all sounds have an electromagnetic component*, created, for example, during every collision between air molecules. The periodicities of electromagnetism, so produced, theoretically follow the same patterns of the sound that created the EM (electromagnetism). I am currently designing an experiment, entitled *Sonic Propagation of Electromagnetic Energy Components* (SPEEC), to prove this principle. If proven, this crucial experiment will have major implications for sound healing. *Put simply, it may be the electromagnetic pattern of energy that triggers the healing response in cells, rather than the sound per se.*

To view beautiful CymaScope images, see ThePowerOfSound.com/Reid

BEETHOVEN AND BONE CONDUCTION

Sheila Smith Allen, MA, OT

Sheila Smith Allen is an occupational therapist with a busy pediatric practice in the New Jersey suburbs of New York City. She's an accomplished sound therapist, as well. In 2000, I asked her why bone conduction was important? Allen explained that with sound traveling through bone thirteen times faster than through air, she observed that an "advance" notification to the nervous system provided extra time for integration of therapeutic sound coming from the ears. For patients with various neurologically based challenges, this made a noticeable difference in the sound therapy efficacy. (*Author's note:* An intrinsic component of the Tomatis Method is the use of special headphones that provide bone conduction of sound. This means that the frequencies of music coming through the headphones vibrate the skull bone along with the regular transmission of sound through the ears. This is accomplished with an additional headphone transducer that sits either directly on the top of the skull or on the occipital bone behind the ear.)

In 2010, I revisited the topic of bone conduction with Sheila, asked her how her thinking had evolved. In her own words . . .

"Back in the late 1790s, so the stories go, a beloved composer, pianist, and conductor, who was suffering from progressive hearing loss, found he could hear sound if he held his baton between his teeth and pressed it against a musical instrument. His teeth and skull, he recognized, transmitted the instrument's vibrations. Supposedly, this virtuoso eventually rigged a metal rod from the soundboard of his piano to his jaw to increase his perception of sound. More commonly we've heard about his efforts to tune-in to the vibrations of flooring, and of his piano, keys and all. Ludwig van Beethoven realized that through the physical matter of his body—his bones, tissues, fluids and gases—he was literally a conductor of sound, *himself*! A conductor indeed! But could he have imagined that some 200 years later, natural 'bone conduction' of sound, teamed with modern technology, would be used to aid hearing, enhance listening, and ultimately improve behavior and performance.

"The musical genius of Beethoven has been revered and studied. The intuitive use of his own body to conduct vibration and sound is a fascinating legend at the very least, particularly since scientific study of *bone conduction* did not begin until a few decades later in 1827. Equally intriguing is the speculation that perhaps the sound stimulation he received by way of his body strengthened not only his ability to perceive sound but to discriminate tones, and perhaps even eased the ringing and buzzing in his ears and the hypersensitivity to certain sounds he experienced as he was losing his hearing.

"Bone conducted sound may have even helped relieve some of the depression, desperation, anger and anxiety he was said to have felt during the years when he was experiencing a devastating loss in his relationship with audible sound. Perhaps it also contributed to the heightened creativity he poured into his compositions during that late period of his career."

BONE CONDUCTION OR IS IT . . . *BODY* CONDUCTION?

Scientific research on the incorporation of bone-conducted stimulation for intervention and wellness is in nascent stages. Empirical study, beginning with the mid-1900s sound research of Dr. Alfred Tomatis and continuing to the present, augmented by widespread anecdotal reports, supports the use of

enhanced bone- and air-conducted sound stimulation to facilitate physical, mental, and energetic therapies for remediation, support, and enhancement of function.

We know bone conduction of sound exists, and its role has been validated with regard to both the auditory and vestibular aspects of the motion-detecting inner ear. Research has established that vibration and sound conducted through bone or other tissue can affect the inner ear—the cochlea or the vestibular apparatus—provided that the vibration is of sufficient amplitude. In fact, recent studies have found that brain tissue and cerebrospinal fluid are effective conductors of sound and vibration, and that bone is not needed for conduction of sound!"[21,22]

While the conduction of sound through the physical body continues to be referred to as *bone* conduction, perhaps it should be called *body* conduction.

Unlike vibration or sound transmitted through the air and then through the middle ear enroute to the inner ear, *bone conduction* of vibration/sound allows sound to reach the inner ear without having to traverse the middle ear. And, unlike *air conduction*, which can directly stimulate the vestibular system, provided that it is intensely loud (potentially damaging to cochlear hair cells), *bone-conducted* sound can stimulate the otoliths of the vestibular system (sensory regions of the vestibular system that tune in to gravitational stimulation) at safe and tolerable volume levels.[23]

Bone conduction also has been found to convey a wider range of frequencies, from 10 hertz all the way up to 100 kHz,[24] the ultrasonic range, compared to the 20 to 20,000 hertz range of audible air conducted sound.

Bone conduction occurs naturally to convey sound/vibration that is both around us and within us. Tomatis emphasized that our voices are our primary source of bone-conducted sound. I suggest that not only the voice, but also oral activity (such as eating, drinking, talking, vocalization, mouth movements, and teeth grinding) provide much of the bone-conducted stimulation we receive.

Benefits

Research has proven the value of bone-conducted sound for hearing aids, audio headsets, cell phones, microphones, and even some exercise and wellness equipment.

The well-established principle of *neuroplasticity* (the central nervous system's ability to change in response to stimulation) and the value of estab-

lishing efficient listening (as promoted by Tomatis) indicate great value in the use of bone conduction. Practitioners and clients using enhanced bone and air conduction in the delivery of sound-based interventions (via high-quality headphones with an embedded transducer to physically transmit the sound/vibration to the head) marvel at the results. Experienced practitioners claim that the inclusion of bone conduction applied in combination with air conduction helps affect change more quickly. Notwithstanding, there is still much to be learned, not only about bone conduction but also about the mechanisms underlying applied psychoacoustics and listening in general.

In my work, primarily with children experiencing problems receiving and processing sensory input, sound/vibration is an integral component. When implementing an individualized program of music-based intervention, listening seems to proceed more smoothly and easily when enriched bone-conduction stimulation is included. Bone-conducted sound/vibration is a synergistic stimulus, integrating the vestibular and cochlear functions of the inner ear, the body and voice, and the inner and outer self.

The Bonny Method Of Guided Imagery and Music, ThePowerOfSound.com/GIM

RHYTHMIC ENTRAINMENT

The use of external rhythms to alter primary body pulses (brain waves, heart rate, and breath) has long been an area of fascination for me. I've always felt that the intentional use of tempo was a primary source of *healing* with sound. The interrelationship humans have with rhythm has been widely explored anthropologically. There isn't a culture on the planet, now and for thousands of years before, that doesn't interweave rhythm into every aspect of life. But what is the effect of external rhythms on the nervous system? I'm pleased to report the continuing sophistication of rhythm and tempo for therapeutic applications.

Neurologic Music Therapy/ Rhythmic Auditory Stimulation

Michael Thaut is a Fulbright Scholar, professor of music and of neuroscience at Colorado State University, and advisor to the World Federation of Neurologic Rehabilitation. He is also a prolific researcher with an emphasis on rhythmic auditory stimulation (RAS).

Per Thaut, rhythmic auditory stimulation is a specific technique to facilitate rehabilitation of movements that intrinsically are biologically rhythmical. One of the most important of these rhythmical movements is gait. Therefore, the most prominent application of RAS is to gait disorders resulting from stroke, Parkinson's, and traumatic brain injuries.

In *Rhythm, Music, and the Brain,* Thaut states:

> By shifting one's notion of music in therapy from functioning as a carrier of socio-cultural values in the therapeutic process to a stimulus that influences the neuro-physiological basis of cognition and sensorimotor functions, a historical paradigm shift has emerged, driven by scientific data and insight into music and brain function. We can now postulate that music can access control processes in the brain related to control of movement, attention, speech production, learning, and memory, which can help retrain and recover functions in the injured or diseased brain.[25]

To that end, Thaut has developed a new branch of music therapy called *Neurologic Music Therapy* (NMT). NMT is defined as the therapeutic application of music to cognitive, sensory, and motor dysfunctions due to neurologic disease of the human nervous system. NMT is based on a neuroscience model of music perception and production and the influence of music on functional changes in nonmusical brain and behavior functions.[26]

Thaut's internationally recognized research focuses on brain function in music, especially time-information processing in the brain related to rhythmicity and biomedical applications of music to neurologic rehabilitation of cognitive and motor functions. When it comes to understanding leading-edge research on entrainment, the work of Michael Thaut and the NeuroRehabilitation Research Laboratory is mandatory.

The NeuroRehabilitation Research Laboratory

Tucked away on a far corner of Colorado State University is a clinical research lab. The NeuroRehabilitation Research Laboratory (NRRL) strives to establish the most effective therapeutic approaches for individuals who have sustained damage to their nervous system. It also investigates changes in the brain that occur following such damage in order to develop a better understanding of the recovery process. The NRRL is staffed with a team of rehabilitation scientists and therapy trainers and is supported by other health care professionals. In 2009 and in collaboration with Thaut, the

NRRL completed a third phase of a rhythmic auditory stimulation pilot study for stroke survivors.

In developing improved stroke rehabilitation methodologies for the recovery of functional movement, RAS is one of the principle therapies the NRRL is investigating. A large body of research supports the use of a rhythmic model of rehabilitative movement training to improve coordination and movement control. Clinical research on RAS demonstrates the effectiveness of rhythmic time cuing, with significant improvements in walking function for Parkinson's patients and stroke survivors.

According to the RAS model, rhythm functions as a cue to stabilize and enhance the organization of movement. In this paradigm, the participant is cued by a stable metronome-like auditory stimulus to reach from one target to another, which produces movement mimicking functional reach. Studies using RAS therapy also demonstrate a significant reduction in the variability of timing and reaching trajectories in stroke survivors. Compared to self-paced movements, RAS reduces the instances of accelerations and decelerations during reaching movements, resulting in smoother movements.[27]

Rhythmic Entrainment Intervention (REI)

"Auditory rhythm has a long history of use for affecting neurological function, with the earliest uses being documented tens of thousands of years ago."[28] As an ethnomusicologist and percussionist, Jeff Strong is fascinated by the commonality in the techniques within disparate cultures. Since 1982, he's devoted his life to understanding how the same basic therapeutic approaches emerged while so many other aspects of isolated societies were vastly different.

Avid curiosity and dedicated research has led to the creation of a clinical application of auditory rhythm specifically designed to stimulate and synchronize the brain. Strong and partner Beth Kaplan have created Rhythmic Entrainment Intervention (REI), a rhythmic sound therapy designed for children and adults with neurodevelopment challenges. While other sound therapies use modulated frequency (i.e., Tomatis), binaural beat frequencies, or classical-based music, REI uses specific rhythm techniques to facilitate improvements in many of the symptoms associated with neurodevelopmental issues. Be it autism, ADD/ADHD, learning disabilities, and more, Strong asserts that consciousness, cognition, and behavior can be affected by employing two specific rhythmic techniques: a repetitive pulse and complex rhythmic structures.

Therapeutic professionals who work with neurodevelopmental issues embrace REI. Occupational therapists and speech/language pathologists, along with parents of special-needs children, assert that listening to custom REI CDs accomplishes improvement in ways that nothing had before.

"As I developed REI, my first step was to identify the core mechanisms of the traditional rhythmic techniques," Strong explains. "It turns out that these mechanisms are simple, powerful, and easily understood. First, human consciousness can be directly affected by an auditory stimulus." Strong labels this concept as auditory driving, wherein a listener's brain wave activity will synchronize with the pulsation of an auditory rhythm (provided certain conditions are met). "Traditional practitioners would employ a four-beat-per-second rhythm, which would in turn facilitate a corresponding four-beat-per-second pulsation in the listener's brain, resulting in bilateral neurological synchronization and a shift in consciousness to a theta, meditative state. With REI, we double the tempo to synchronize a listener's brain into a relaxed neurological state called alpha. This is the state of consciousness where sensory processing is optimized."

In addition to *alpha brain wave entrainment,* Strong discovered that another core mechanism involved in traditional therapeutic rhythm techniques consisted of using *complex rhythms to activate the brain.* He asserts that complex auditory rhythm stimulates the reticular activating system, a part of the brain that controls sensory input. Applying complex rhythm to activate the brain is one level of the stimulation; however, multiple research studies provided Strong and his team the awareness that perhaps more important than complexity, *each rhythm produces a different response.* Understanding that traditional rhythmic practitioners (i.e., shamans) performed rhythms live for each person and adjusted their rhythms based on the responses they saw in their patient, Strong set his attention on how to provide rhythmic stimulation using CDs. The REI team found that while they created universal calming effects with their rhythmic formulas, specific rhythms had a different effect on each listener. As of this writing, they've documented over six hundred rhythms that seem to correspond to symptoms and combinations of symptoms. REI believes it is critical to use just the right rhythms for each person in order to have the greatest positive benefits for that person.

REI research and further information can be found at:
ThePowerOfSound.com/StrongInstitute

ReSet

ReSet, a tempo-based auditory program, is a means of *sonic bridging* to support efficient transitions and effective engagement. Psychoacoustically modified classical music and silence are sequenced in 10- to 20-minute sound tracks designed to slow, settle, or activate the listener, helping to pass from one state or activity to another.

ReSet differs from previously mentioned auditory-based programs in two ways. First, it is in the intermediate stages of research and development, with trial use by people of all ages who are normally functioning and children and adults with a range of sensory, physical, communication and behavioral issues. Second, ReSet is a program that I coconceived and developed with occupational therapist and sound practitioner Sheila Smith Allen, MA, OT.

Healthy transitions: The ability to tune in, reset as needed, and engage . . .
The focus of ReSet is transition. Transitioning means to change, to shift, to move from one state or activity to another. Transitions are a part of life, from the innumerable changes that make up daily living to the major transitions presented by the journey of living. Transitioning is a life skill. For some, that ability comes naturally and moving from one activity to another in the course of a day is typically accomplished with relative ease. These people are able to tune in, reset as needed, and engage. For others, transitioning presents a big challenge and negatively affects daily experience. For these people, time spent trying to "get in the groove" interferes with focused intention, interaction, and adaptation. Transitioning challenges may be a by-product of living a fast-paced, overstimulating, stressful lifestyle or transitional issues may be related to identifiable conditions such as sensory processing disorder, autism, anxiety, ADD/ADHD, PTSD, sleep disorder, age, and stress.

Several established psychoacoustic techniques are applied to a ReSet listening experience, including:

- **The *iso principle,*** where the tempos *meet* the person at their range of heart rate or breath and slowly *escort* them to the desired body pulses conducive to specific activities.
- ***Entrainment*** applied to the speed/rate of the music in time (tempo), which progressively and seamlessly decelerates or accelerates.
- The relationship between ***sound and silence*** has been clinically

researched. Music with interludes of silence has been proven most effective for deepening relaxation.

- ***Steadiness and predictability of rhythm*** necessary for *passive hearing* and states of auditory habituation.
- Variation in ***melodic complexity*** and orchestral density are used to encourage auditory states of active listening.

Clinical testing of ReSet began summer 2010. Results and further information are posted online at **ThePowerOfSound.com/ReSet.** A ReSet sample can be found on the CD included with this book (Track 13). Downloads can also be found at Reset-Tempo.com and EssentialSoundSeries.com.

BRAIN MUSIC THERAPY

A Russian psychiatrist in New York City measures your brain waves and e-mails them to her old professor in Moscow, where they are put through a "*brain-sound compiler*." Two compositions (relaxation and energizing) are created and digitally sent back to New York. For about $500, you now have a CD with the musical correspondences of your unique brain-wave pattern. Dr. Yakov Iosifovich Levin, a highly esteemed professor of medicine and director of the Russian Ministry of Health's Sleep Disorders Center, has created a brain-sound compiler that transforms sixteen-channel EEG[29] traces into music. Equipped with eighteen different transformation logarithms and capable of creating changes in tempo, varying the volume of each channel, transposing the music of each channel to different octaves, changing musical parameters (for example, legato or staccato), adding major and minor chords, and analyzing the note patterns of each channel, the brain-sound compiler sounds like just another sequencing synthesizer. *What makes it unique is that the sound source and sequence are EEG-recorded brain-wave patterns.* Why go to all this trouble for a musical composition? Apparently for the nonpharmacological treatment of insomnia, anxiety (i.e., panic disorder, social phobia, generalized anxiety disorder, or post-traumatic stress disorder), depression, attention deficit hyperactivity disorder, or migraine and tension headaches.

According to Levin, "In order to prove efficiency and safety of the method 'Music of the Brain' and to meet the requirements, we performed a double blind research with placebo. We used 'music of the brain' of different patients as a placebo. The results of this research confirmed high effi-

ciency of the method and showed that it is also absolutely safe, as there were no indications of side effects or complications." The method Music of the Brain is officially recognized and has been awarded with a certificate of the Ministry of Health of the Russian Federation.[30]

New York City–based Galina Mindlin,[31] a veteran of psychiatry with more than twenty years of experience, a medical degree, and two doctorate degrees (neurophysiology *and* neuropsychology) is the chief proponent of BMT in America. When patients arrive in her office, a brief evaluation is taken. Mindlin uses guided imagery to facilitate the patient into a relaxed state and then performs an EEG recording. This becomes the source material sent to Moscow. Within three weeks, patients are sent a CD based on their unique brain-wave combinations.

Unique, one-of-a-kind music that resonates and entrains the brain? BMT presents an auditory mirror image of brain waves. It works, but nobody seems to know how or why. Here is Levin's best shot: "The main idea of this method is to change a current functional stage of the brain by listening to music that has been recorded after transforming the patient's brain waves into the sound tracks by using specially designed computer software."

Mindlin's take: "Brain music therapy is a form of neurofeedback, which is based on a variable ratio of fast and slow rhythms. The predominance of an individual's slow rhythms corresponds to the relaxing, soothing mindset. Just as our brain is capable of recognizing a familiar sound, like your own voice, it is capable of recognizing a deeply imbedded sound of its own brain waves."[32]

ThePowerOfSound.com/BrainMusicTherapy

THE CENTER FOR NEUROACOUSTIC RESEARCH

Dr. Jeffrey Thompson, DC, BFA, has been experimenting with sound scientifically since 1980. He first started in his Virginia Holistic Health Center, which grew to be the largest center of its kind in Virginia. His experimentation was in using exact sound frequencies to make chiropractic spinal and cranial adjustments, to stimulate and normalize organ function, and to balance acupuncture meridians. He developed a very gentle and effective method of making adjustments and continues to use this approach today—on people and on horses!

Currently, under the mantle of the Center for Neuroacoustic Research, Thompson is a practicing clinician, the creator of Bio-Tuning Behavioral

Psychoacoustic Therapy, producer and musician for more than ninety audio programs, consultant to Fortune 500 companies, creator of vibroacoustic devices, and a prolific sound researcher. He is always a thought-provoking guy on the cutting edge of sound. I looked him up in November 2009. We spoke about his applications of music and sound with hospices, in sports, and with combat stress and PTSD. For a thought-provoking interview, kindly join us online.

ThePowerOfSound.com/JeffreyThompson

SONIC NEUROTECHNOLOGIES (SNTs)—TOMATIS, BINAURAL FREQUENCIES, AND VIBROACOUSTICS

As was thoroughly discussed in chapter 15, SNTs are sound-processing techniques known for resonant neurological effects. There are currently three major technologies that define this field: binaural beat frequencies (BBFs), filtration and gating (F/G), and vibroacoustics. They share only a few things in common:

- All techniques use music or sound.
- All techniques use psychoacoustic principles of resonance and entrainment.

In relationship to BBFs and F/G:

- Headphone application is preferred.
- Sound processing is performed on a sound track (music, nature, or white noise). This generally involves adding or subtracting elements of sound to or from the original recordings. The BBF technique adds detuned pairs of frequencies; F/G subtracts large spectrums of sound and then gradually adds them back in.
- The two sound approaches of BBFs and F/G are very different in origin; they have diverse goals, and they are not used in tandem. The following information, geared toward educators and health care providers, refers to material contained in chapter 15.

For Further Information:

- Binaural beat frequencies: Please see page 182 in chapter 15.
- Tomatis: Please see page 48 in chapter 5 and page 173 in chapter 15.

CLINICAL MODELS USING SOUNDWORK

I have compiled a list of clinics that are exemplary of how health care providers and educators integrate soundwork into—or built entire practices around—therapeutic sound techniques. In each case, sound occupies a different setting within the standard protocol.

For direct clinical model links, refer to ThePowerOfSound.com/ClinicalModels.

Online presentations provide a substantive picture far greater than space in this chapter permits.

- Bancroft Center of Chinese Medicine (acutonics)
- Brain Music Therapy Center (brain music therapy)
- Cleveland Clinic Arts & Medicine Institute (arts and health care)
- Cymatherapy
- Equine Cymatherpy
- Davis Center for Hearing, Speech, and Learning (audiology)
- Guided Imagery and Music
- Mitch Gaynor, M.D. (oncology)
- National Academy for Child Development (neurodevelopment)
- New Visions (neurodevelopment/feeding issues)
- Dr. Fred Schwartz (anesthesia)
- Pediatric Therapeutics (pediatric neurodevelopment)
- The Center for Communication and Learning Skills (sound stim)
- The Institute for Music and Neurologic Function (music therapy)
- The Louis Armstrong Center for Music and Medicine (music therapy)
- The Swain Center for Listening, Communicating, and Learning (sound stim)

Institutional Venues and Soundwork

In addition to use in clinics and individual practices, soundwork has been incorporated into institutional venues as well. From birthing to hospice, dentistry to surgery, psychotherapy to treatment of Alzheimer's, soundwork has been extremely effective. On the website, I have chosen a few research studies to demonstrate how it is being used.

ThePowerOfSound.com/InstitutionalVenues

WHERE DO I GO FOR RESEARCH?

Research into the effects of music and sound currently abounds as a result of improved measurement techniques. In 2000, concerted, coordinated efforts were not in place; in 2010, music neuroscience has become the fulcrum interlinking music and sound therapies. (See chapter 8, *Neuroscience and Music*.) The adoration of music, as we know, is a global phenomenon with deep roots. To use music in an application-specific manner is a bonus truly appreciated by everyone.

Consequently, American and European media frequently report research involving music and sound. The organizations on the website are a sampling of organizations looking deeper into music research. Many hold conferences and coordinate research among their members. Hopefully, in the not-too-distant future, research coordination will not just be within one organization, but *intra*organizational, as well.

For direct links and further information about research resources, see: ThePowerOfSound.com/WhereResearch.

CONCLUSION

Soundwork is a diverse field and growing all the time. So many professionals—be they music lovers or former musicians—see the sense of incorporating music and sound into their professional endeavors. A familiar scenario goes like this: I receive a phone call from a doctor in Pennsylvania. He tells me that his wife is about to give birth for the first time, and he wants to know what music would be appropriate to keep down her stress level. In further conversation, he explains that he played the trumpet as a teenager but then abandoned it when he went to medical school. However, he has always known that music has a special effect. He is too busy to play an instrument at this stage of his career but has never forgotten what drew him to music initially; he loved the way it felt to be in that swirl of sound and harmony.

Flash forward one year. The same doctor is now the father of twins, has attended a professional conference of an international medical association dedicated to the clinical study of music in medicine, and has enrolled his hospital in a research project involving music in the surgical environment.

Three years later, the doctor is applying for grants at the National Institutes for Health. He has created a standing committee at his hospital

to add music to the environment in numerous ways. In his spare time, he is again playing the trumpet.

WHO LET THE DOGS OUT?

I'd like to end this chapter with an inspiring, heartwarming story reported by Melinda Beck for *The Wall Street Journal*—of all places! It is titled *A Key for Unlocking Memories.*[33]

> David Ramsey, a music therapist and psychologist, holds twice weekly sessions at Beth Abraham (hospital), where small groups of patients can sing and dance to familiar songs like "Under the Boardwalk" and "Swing Low, Sweet Chariot." Mr. Ramsey will sometimes stop singing and let residents fill in the blanks on their own. When they do that, he says, "they are exercising their cognitive function—just like they are exercising in physical therapy." And unfamiliar songs quickly become familiar, another sign that even advanced Alzheimer's patients are forming new memories. "One of our therapists played, 'Who Let the Dogs Out?' I know they had never heard that one, but it became an anthem," he says.

CHAPTER 18

The Anatomy of Psychoacoustic Music Creation

As a music producer, I've developed some psychoacoustic techniques that may be of interest to producers and musicians who wish to expand into the territory of application-specific sound tracks. Because no one is born a "psychoacoustic producer," I'd like to share a little of my background. This brief story sets a context for what I've learned and helps explain why I feel the instruction of both musicians and health care professionals in the use of psychoacoustics is of vital importance to the growth of the field.

In 1986, I left commercial composing. At that time, I was living in Hollywood and had acquired credits in radio, stage, corporate, and live musical production. I was gradually moving to the next level—TV and film composing. Yet something was personally incongruous in this pursuit; I didn't even own a TV! I couldn't tolerate the overarching violence, mindlessness, and commercialism of TV programming. There I was, though, chasing the money and prestige of the genre. While film composing was my goal, TV composition was part of the logical progression. Be it TV or film composition, however, I witnessed the intense hurry-up-and-wait, late-and-over-budget routine that plagues Hollywood composers. It just didn't add up to me.

At that time, my path crossed with Louise L. Hay, a Science of Mind counselor. She is the founder and owner of Hay House, the world's larg-

est publisher of self-help and human potential books, videos, and audio programs. She has written more than eighteen books, including the bestselling *You Can Heal Your Life,* which originated from a small pamphlet called *The Mental Causations of Physical Illness.* A believer in the power of affirmations to reprogram the mind and the simple use of love and forgiveness, she was available for private sessions in her Santa Monica apartment. As demand grew, she had also begun to release audiocassettes with her meditations and affirmations.

We liked each other on meeting and decided to collaborate. Between 1986 and 1989, I produced three albums with Hay. During that time, I watched her work with large gatherings of people suffering from a new epidemic—AIDS. I observed groups chant and sing from the deepest part of their psyches. Many of the affirmations were from albums Hay and I created. Out of these experiences a major shift took place for me. As a musician, I saw and heard the difference between music written for entertainment and music written for healing. After that, I could never go back to chasing TV scripts.

In 1991, I placed an ad in a retail trade magazine for an album containing material I'd written with Hay.[1] The magazine's editor asked if I would be interested in writing an article about healing music. I declined. When asked why, I explained that I didn't really know what I was doing. I was "making it up" from instinct and intuition. Certainly this would not make for a credible article! The editor was intrigued, however. He called back a month later and asked if I was ready to write. Once again, I turned him down. At that point, he became insistent. The following month he called again, this time offering to send a book that he hoped I would read. Then, perhaps, I would begin to write.

I am forever indebted to the obstinacy of editor Jeffrey Isbrandtsen, for through the book he sent, I was introduced to *psychoacoustics*, a term and a field I didn't know existed. *The Healing Forces of Music* by Randall McClellan, Ph.D., is a seminal work and one that I highly recommend to this day (see bibliography).

Deeply inspired and intrigued by what I read, I did write an article, and it sparked a voracious appetite to learn about psychoacoustics, so much so that I published another twenty-four articles in *New Age Retailer* in the following four years.

My column was called "A Sympathetic Vibration: Music and Sound in the Healing Arts," and I was given carte blanche to explore this widening field of psychoacoustics. I interviewed every leading psychoacoustic soundworker

I could find. My agenda was clear: "I am a composer looking for the deeper meaning inside the notes. Let me ask every appropriate question I can think of, and in exchange I can have your ideas published." It worked! Thus began my education in psychoacoustics. There was no place to study other than with the disparate individuals dedicated to working with sound.

One of the most interesting things I found was that most of these people were working in their separate laboratories of sound, absolutely committed and utterly isolated. Most did not know of each other's work, and many were leery of sharing. I was considered safe because I didn't have turf to protect: I wasn't a vocal toning adherent or a binaural frequency proselytizer. At the time, I didn't even know who Alfred Tomatis was. Many felt *their* way was the best way. But I was obviously eager and innocent. Almost every practitioner I visited took me in with an open heart and became a teacher. My first book, *Sonic Alchemy,* was the result of these years of travel and inspiring discussions (see the bibliography).

Because of the large amounts of time it took to transcribe and edit in-depth conversations, I had the opportunity to truly consider the words and ideas of my new teachers. As I did more and more interviews, I began to see both similarities and differences in approach among these practitioners. It was from the synergy of their combined thoughts that my theories began to germinate. I have stood on their shoulders and now take what I've learned and make it publicly available. I hope to help propel the field of psychoacoustics to its next generation.

During my time with the magazine, a fringe benefit surfaced. Because I was writing about psychoacoustics, all products of this orientation that were submitted for magazine review were forwarded to me. Consequently, I also had the opportunity to survey everything coming to market. I unintentionally became an authority on commercial psychoacoustic products. What I found was a lot of good intention and technology—and, for the most part, extremely poor art. The aesthetic side of the music and production appeared to be a low priority of the creators, mostly because it's pretty tough to be both a scientific wizard and a brilliant musician. Most worked on a shoestring budget and were noble in their efforts to get something out to consumers.

So what has changed since 1991? I am pleased to report that new generations of psychoacoustic products are coming on the market. The more information becomes available—and there have been numerous books published in the last decade—the smarter musicians get. As the marketplace begins to accept psychoacoustics as a genre (distributors refer to it as therapeutic music

and sound, sound tools, and psychoacoustics), more musicians find they can afford to move their efforts into this arena. The net result is a marriage of art and science, advancing psychoacoustic refinements of music and sophistication in production and presentation. These are goals that I support.

I foresee that soon there will be *over-the-counter* sound products and *prescriptive* sound therapies. As programs become more effective and pleasurable to use, the marketplace will embrace the concept of application-specific musical products. This should lead to mass distribution and greater use. Wide public acceptance and use of music and sound tools supports the field of soundwork as a bona fide therapeutic modality and life enhancer.

Following this train of thought . . . the better sounding, more clearly explained, and more highly documented and researched psychoacoustic programs become, the greater will be their acceptance. Sonic neurotechnologies aside, it is the "sound" of the programs that will make all the difference. If something tastes bad, people don't put it in their mouths. Same thing with the ears. It is up to the musicians and producers to create sound tracks that host the technologies but are also wonderful enough to warrant repeated listening. In this conviction—of the necessity for combining high art with substantial science—I share what I've learned about psychoacoustic music production.

WHAT'S GOING ON IN THAT RECORDING?

The enclosed CD, *Music for The Power of Sound,* contains selections performed by The Arcangelos Chamber Ensemble. Tracks 1 to 12 of the Sound Health Series were produced between 1996 and 2000. I greatly appreciate the award-winning and patient players of Arcangelos, who served as the "workshop" from which many of these psychoacoustic techniques derive. An additional thirteen-minute track (#13) was produced from 2003 to 2005 and emanates from The Essential Sound Series. The four compositions of track 13 were performed by the Apollo Chamber Ensemble, featuring pianist Lisa Spector. This arrangement was designed for ReSet, the therapeutic series devoted to tempo-based entrainment to facilitate transitions (see page 225).

I am assuming that by this point in the book, you have a solid grasp of the cornerstones of psychoacoustic music production: resonance, entrainment, pattern identification, and sonic neurotechnologies. If not, please review the appropriate chapters. Knowledge of tone, tempo, and pattern are necessary

if you are to understand the purpose of the following techniques. I will be referring to these components often.

INTENTION

The starting place of any psychoacoustic production is intentionality. *What do you want to accomplish with your sound program?* Is the intended recording designed to aid falling asleep, or is it for accelerated learning? Let's briefly examine these different poles of activities.

Sleep, beyond meditation and stress reduction, is as slow and low as you can get. Accelerated learning, on the other hand, is bright and active. So which brain-wave state and heart rates are most conducive to these particular activities? What is the best combination of resonance and entrainment to achieve these goals? If you are interested in beta brain wave states for accelerated learning, the music will be faster and the orchestration will be higher (● tracks 9, 11) (see "Music for Focus, Concentration, and Learning" on page 110). If a delta brain wave state is the goal, go for slow tempos and lower orchestrations (● tracks 3, 5, 8, 10).

Entrainment and resonance at play: these are the tools for naturally influencing the pulse systems of the body (brain waves, heart rate, and breath). The balance and alchemy of entrainment and resonance, with the possible addition of an appropriate sonic neurotechnology, is the psychoacoustic palette from which you will paint.

Psychoacoustic production is about common sense and conscious recognition of music's subtlety, which is what makes it so powerful. Most people do not realize what is taking place when they listen to music, so they are not psychologically armored against its impact. This makes it easier to influence them, and it also increases the importance of ethical intentionality. Once the goal and benefits of the music are defined, you can move on to other considerations.

CHOICE OF MUSIC

Our psychological response to any piece of music can enhance or negate the effect of a sound tool. If listeners don't like the sounds they're hearing, they won't want to listen. This is a simple fact. To facilitate effectiveness, you must determine a couple of things when you choose your music:

- Who is the intended audience and what kind of music will be best suited for its enjoyment?
- What kind of music is appropriate for the psychoacoustic treatment you will visit on it?

Let's examine the "intended audience" consideration. One of the lovely people I interviewed in *Sonic Alchemy* was Dr. Fred Schwartz, an Atlanta-based anesthesiologist and former saxophone player. In the operating room, Schwartz has as many music CDs on his anesthesia cart as he has other medical tools. He is an innovator in the use of music and anesthesia and is highly respected for his work. Schwartz shares a poignant story: "I've always loved music and thought it had a lot of applications. Beginning in medical school, I used music with some of my patients. But what really affected me profoundly was when I was an intern, working in an intensive-care unit.

"I had a seventeen-year-old fellow who had a motorcycle accident. He had become comatose from the head injury. I was taking care of him and spending a lot of nights there. He wasn't responding to anything and it had been weeks already. So I started playing flute to him and his eyes would move when I played the music. So I thought, 'Gee, he is responding, there is something there.'

"We kept playing him music. His parents bought him a radio, and rock 'n' roll was what he liked. He woke up and made a full recovery three weeks later. And he remembered the music and it turned out that he didn't really like flute music at all!

"That's why he was moving his eyes! He was trying to tell me to stop. He came back from the near-dead to tell me, 'Let me die in peace, leave me alone, already!' That impressed me."

If the style of music is disliked, it will have a diminished effect. In the story above, the young man could not get up to turn off the CD player. But most people can and will. Let's look at another illustration of musical taste.

Rap music is now firmly entrenched in our American culture. Many wish it would go away; they find it offensive, monotonous, even irritating. In all likelihood it will not be looked on a hundred years from now as a great American innovation in art, such as jazz. Yet it is flourishing. Why?

Think about the structure of rap music. The basic elements are drums and bass. (This is your first tip-off to the entrainment and resonance

effects.) Drum machines in rap put out a slow and steady 4/4 rhythm. The bass is predominant and turned up loud in the mix. What is the psychoacoustic effect of this sonic mixture? The slow rhythms entrain the nervous system down. The overabundance of bass frequency overloads the nervous system and causes a discharging effect. Put these entrainment and resonance elements together and you have a perfect prescription for sonic Valium. Psychoacoustically and physiologically, rap music is not an upper; on a pulse-entrainment level, it is a downer.

As an art form, rap has become prevalent in our culture because white youths, with the help of savvy advertising, want to musically emulate the African American culture, and because it is great self-medication. If I were an inner-city teenager with family difficulties, friends in jail or dead, and little hope for the future, I'd be self-medicating however I could. The fact that music is such a strong tool in the arsenal of self-medication only reaffirms the belief in the power of music. Rap is a perfect example of psychoacoustic products as a tool in our lives. A psychoacoustic exploration of rock or heavy metal music indicates that the characteristic tempos and timbres create a slightly different result. Rock, in its many manifestations, is usually more uptempo than is rap. The consequent brain wave states will most likely be in beta rather than rap's low beta or alpha. Heavy metal relies on the distorted sounds of electric guitars. The primary audience for heavy metal is teenage boys. Something about the resonance of heavy bass, loud kick drum, and guitar distortion seems to soothe excessive testosterone. Venturing a guess: the heavy bass discharges while the distortions preoccupy the auditory function. (Imagine what the auditory system goes through to decipher and analyze, in real time, the sound of distortion.) The purpose of this conversation is not to judge, pigeonhole, or generalize different styles of music. Rather, my goal is to stimulate your analysis of the effects of tempo (entrainment) and tone (resonance). Therefore, concerning the question of intended audience and musical choices, classical music would probably not be my top pick if my goal was sound tools for teenagers—too much generational resistance. I would instead go for music that they like to listen to, or find a way to entice them into something unusual and fun in other styles. Because musicians, let alone psychoacoustic producers, are not state subsidized, markets must be chosen carefully to ensure economic survival. Most likely, teenagers will not be first-line psychoacoustic record buyers. That being said, there may be youthful surprises in the near future.*

Thus, my choice is to cater to the adult or children's marketplace. For children, fun and engaging theatrical presentations create the perfect backdrop for sonic neurotechnologies. With adults, any of the musical styles can work, although I find classical music to have universal appeal. It is a known quantity, beautiful and rich in possibility for adaptation. This segues into the second consideration: what kind of music is appropriate for the psychoacoustic treatment you will be visiting on it?

When I speak of psychoacoustic treatment, I refer to the different processes of resonance and entrainment necessary to achieve your goals. You will most likely rearrange the music you are adapting in order to accentuate rhythmic pulse, raise or lower pitch, change orchestration, and simplify melodic content. (I will cover these areas in detail shortly.) The main consideration is what kind of music is most easily adaptable. I find that classically oriented music addresses both personal taste and adaptability. Still, I encourage you to try these principles in other musical styles to help diversify the field.

So our bottom-line questions about choice of music are:

Will your demographic like it?
Is it adaptable?

ENTRAINMENT

In this book, I have extensively discussed entrainment and the role it plays in psychoacoustics. Entrainment is integral to any musical effect. Not only does it affect our internal landscape through external tempos, but it is also the vehicle by which our body pulses synchronize with each other. Given that rhythm is ubiquitous, entrainment is a vital influence.

So is this valuable tool used in production? I have an awareness of it at all times. For the most part I try to create in the music an easily distinguishable pulse. This makes it easy for the nervous system to latch on and take a ride.

An overarching concept in soundwork is trust. In my productions I do everything I can to win my listeners' ears. My goal is to help them feel so safe

*In a 2000 class I taught in New York City, I was pleasantly surprised at the number of DJs in attendance. I asked for a demo of the coolest software (laptop computers are the instrument of choice for modern DJs) and found that the psychoacoustic possibilities—at the fingertips—were abundant. I look forward to hearing mixes and mash-ups with a psychoacoustic emphasis in the very near future.

in the arms of my sounds that they will go anywhere the music takes them. I picture an escalator with very comfortable chairs in which listeners gladly recline. With such beautiful sounds and gentle rhythms, they have nothing else to do but to come along for the ride.

The only time I don't use easily felt entraining pulses in my production work is when I want no rhythmic movement at all. When I coproduced Andrew Weil's *Sound Body Sound Mind,* the purpose was to take the listener to a place most conducive to self-directed healing. The sixty-minute sound track started with a tempo of about 120 beats per minute. Over the first twelve minutes, coproducer Richard Lawrence (1946–2005) and I gradually ramped down to the slowest rubato space we could create. We remained there for thirty-six minutes. Toward the end of this segment, we very gently added a slow tempo, gradually ramping back up to a waltzing pulse of about eighty beats per minute. In the rubato section, called "The Deep," our job was to create a sonic space that wouldn't disturb theta and delta brain waves. We had to make sure we did nothing to disturb someone in this space of delicate, subconscious access that had been achieved by our entrainment and the addition of binaural beat frequencies. In this section, rhythm would have been jarring and counterproductive. We made every effort to stay out of any form of pulse. To accomplish this nonentraining effect, we used non-Western instruments—sitar, Bansuri bamboo flute, tamboura, Tibetan bowls—all sounds that could fill the space yet be out of the world of rhythm. Yes, we could have used Western instruments, for any instrument can play rubato (without tempo). But we felt that because we had employed Western instruments in a classical context in the ramping down and then back up, something completely different would contribute to the sense of freedom from form.

One of the vehicles I employed when working with the Arcangelos Chamber Ensemble is pizzicato—lightly plucking strings, rather than using the bow. This provides a gentle rhythmic pulse. Quite often Lawrence and I would take an existing internal voicing and have the string players pluck each note instead of using the normal legato bowing. The effect, especially with multiple players, is a wonderful round sound that provides an easily recognized rhythmic pulse. ● Track 8 on the CD is our arrangement of Vivaldi's Largo from the Oboe Concerto in B♭ Major. When listening to this arrangement, notice the use of the pizzicato. It creates an ongoing, nonobtrusive effect. Yet psychoacoustically, this gentle plucking becomes an escalator. Your nervous system locks on to this external periodic pulse

and will match it. Volumes can become quite low, yet the nervous system is attuned to the rhythm.

Often, in the course of a piece, we will either gradually speed up or slow down, depending on where we want to take the listener. Effective use of entrainment involves the periodicity of the tempo. Therefore, the goal is to stay as regular in pulse as we can. If we become too erratic, the entrainment will not be successful. Notice how on track 6, our rendition of Mahler's Poco Adagio from Symphony no. 4, the pulse is set by the pizzicato bass, then gradually slows, then slows even more. Using the iso principle, our goal was to sonically meet listeners near the tempo we imagined their body pulses would be when first lying down. The intention of the album is to facilitate falling asleep. Therefore, our destination, simply put, was to transport the listener into as slow a zone as we could. By the end of the piece, notice how we reach almost a nontempo state. In the process, the bass pizzicato comes in and out. But because we established this as the pulse initially, we assume that each time it returns it is recognized as the rhythmic escort. With entrainment, that is essentially what we are doing. We are merely a body pulse escort service!

The Mahler arrangement on track 6 comes from the Arcangelos album titled *De-Stress*. The selection that follows it starts with ocean waves that match the tempo of the ending Mahler. Using waves as the entrainment device, we set up a continued slowing pattern. Our hope was that referentially, people would equate the sound of slow ocean waves with deep relaxation. The sounds of the distant water resonate in the lower frequencies. This also serves to discharge the system.

In listening to this piece now as I write, what occurs to me is that you don't need to be a rocket scientist to figure out that the slower a piece of music, the more it will make you fall asleep. My goal in these explanations—beyond the obvious—is to point out the architecture that allows for subtle application of these principles.

Notice in my descriptions I often state "we hope" or "we assume." Many things can be proved with precise, high-technology measurement. Other things are left in the province of intuition and experience. Remember, we are talking about the art of psychoacoustics in addition to the science. In that realm, boundaries are always being stretched. This is how innovation takes place. We try things, see what kind of feedback we receive, and either embellish or discard. I urge you to do the same.

A brief word about entrainment and habituation. One of the ways the

brain conserves energy is by determining patterns in things. Once this takes place, an event can be filed away. The brain has habituated to the incoming pattern and decided it is safe; active awareness shifts elsewhere. This takes place with many of the senses, not just sound. When it comes to rhythmic entrainment, there are two paths to consider with habituation.

If you *want* habituation to occur—no ongoing (active) listening—keep rhythms nice and steady. Habituation is a good thing in less-active brainwave states, such as alpha, theta, and delta. However, if you want to keep the listener in a beta state, you will be more successful by avoiding habituation. You want the brain to stay tuned, to actively listen. Think of *listening* as active, focused attention and *hearing* as passive sound awareness.

To keep the brain in a highly focused mode, don't allow habituation. The way that I achieve this is by subtle changes in ongoing tempos. This is a little tricky, because entrainment is based on periodicity, which is ongoing and nonerratic rhythm. To accomplish subtle changes that remain within the bounds of periodicity, I recommend prerecorded click tracks with the musicians in the studio. Rather than a steady eighty beats per minute, a click track gradually moves between seventy-eight and eighty-two beats per minute. These subtle tempo changes, although not necessarily decipherable to the ear, serve the purpose of keeping the auditory system alert. Because tempos do not fit an ongoing pattern, active listening is kept in place. This requires beta brain waves.

Other entrainment devices include the use of anything percussive that can establish an easily listenable sound. Drum machines, however, are my least favorite entrainment tool and probably the least effective. Periodicity is necessary, but nothing in the human body beats at the perfection of a machine. The result is a rebellion of listeners' bodies. They get irritated and simply say, "Shut that damn thing off!" Once they do that, you are out of luck. Entrainment is never a forced event.

RESONANCE

A core concept in soundwork, developed by Tomatis, is that sound is a nutrient for the nervous system. Tomatis believes the ear should be considered differentiated skin, that actually the entire surface of the body perceives sound. He believes the body *hears*. This takes place through the perception of vibration.

This concept pervades my psychoacoustic producing. As with entrain-

ment, the effects of resonance and tone are ever present in my artistic and psychoacoustic judgment calls. Listen to track 10 on the CD, Bach's Largo from Concerto no. 3 for Two Violins. The purpose of this piece is to enhance accelerated learning via the body relaxed–mind alert state described by Georgi Lozanov. Rhythmic entrainment was used to slow the heartbeat to fifty to seventy beats per minute for the body relaxed state. This is known as the ideal relaxed heart rate. To achieve the mind alert side of things, we relied on resonance.

To accomplish this, a few psychoacoustic refinements were put into place. This means we changed something from the original to make it more application specific. For increased concentration, we wanted to stimulate the nervous system. Therefore, we changed the orchestration. Originally, Maestro Bach voiced this beautiful piece for two violin lead instruments. We used flute and clarinet instead. Why? Because we felt that the high woodwinds would cut through the background voices a bit more. We wanted the high register of the clarinet and flute for "charging" purposes. To ensure this, we considered changing the key to a higher register. We ended up not doing so because we found it to be more artistically pleasing the way it was written. This makes sense; Bach was a genius. We are never out to try and improve these masterworks, but, rather, we respectfully adapt them so they are as psychoacoustically efficient as possible. Bach's motivation was different from ours. Most of his music was written with a seventeenth-century church audience in mind. In this instance, with due deference to God, we are thinking mostly about increased productivity in the classroom or office.

Let's take the example of high and low frequencies in the other direction. If our goal was to slow down the nervous system, Lawrence and I would lower a key if necessary and use midrange instruments (viola instead of violin, French horn instead of trumpet, alto flute, and the like). If we were using a piano, we might instruct the pianist to keep most of his work in the midrange.

We often used nature sounds in our work for resonance purposes. If you look at the sound of crickets or wind on an oscilloscope, each is in the 5,000 Hz range, with a visible first harmonic at about 10,000 Hz. This is a "charging" frequency range. Therefore, it becomes easy to pick nature sounds for their resonance factors as well as their creative, entraining, or psychological impact.

SIMPLIFIED MELODY LINES

When picking a repertoire for a particular project, my coproducer and I would go through one hundred pieces on the first pass. We would then each pick the twenty movements we thought best suited for the purpose. From our secret ballots, we looked for joint selections and hoped there would be ten or twelve. Somehow, like old card collectors, we'd swap a Vivaldi for an Albinoni and end up with the right mix.

Often, we both loved a piece of music that completely worked for the application, but it might include a sixteen-bar phrase that absolutely did not work. Remember, our vision of the music's end use is almost always different from the composer's original assignment.

We used a lot of slower movements in our work. Interestingly enough, largo selections can usually be used as is, but we often find that the adagio and andante movements contain sections that become more dissonant or busier than the rest of the piece. Clearly, tension is integral to creating release. The composers didn't want their audiences to fall asleep or get too relaxed in the original environments. Remember that in a symphony, usually only one of the four movements is on the slower side. If they got too relaxed, listeners would be snoozing in the pews or concert hall. Given that psychoacoustic refinements might be warranted for our applications, what could two conservatory-trained arrangers do? One of three things: completely omit the section that is not appropriate, keep in the section but take off the lead line and allow the inner voices to take the forefront, or run for the hills because in America, playing the piece exactly as written is sacrosanct. However, Arcangelos concertmaster Richard Lawrence reassured me that it was common practice for seventeenth- and eighteenth-century European composers to riff on each other's pieces. They were improvising and changing the masterworks much the way today's pop and jazz artists create new renditions of older classic tunes.

So what is the effect of editing out a section that is not psychoacoustically relevant? If we do it right, listeners don't even know it's gone. Such is the case in our rendition of Mahler's Poco Adagio (track 6). In many instances we were looking to soothe the psyche. If too much tension is in the original piece, it will not work. Because we had our own chamber ensemble and recorded all our albums from the ground up, we are able to make these changes. Much classical music on the market—in the "Lifestyle" marketing category—cannot duplicate this. Its producers are dependent on existing archived recordings.

The effect of deleting just the lead line is most interesting. On track 12, you will find the Bach Allegro Assai from the Violin Concerto no. 2 in E Major. This is a good example of inner voices brought to the surface. Notice how we started off with a low pizzicato arrangement of the inner voices with everything else omitted. In the second stanza, we brought in the melody line; in the third, we returned to the inner voices in pizzicato. For the fourth and sixth stanzas, we played the inner voices legato without any lead line. They are as beautiful and fulfilling as any aspect of Bach. The interesting thing is that with a sixteenth-note lead line usually above them, unless you are reading a score, you would not be able to focus on them; they are background and subservient. But brought to the surface to shine on their own harmonic merit, they are wonderful undiscovered gems. The reason we pulled the lead lines in these instances was because the music became too busy for our purposes. We felt that it would cause distraction when we wanted to create unobtrusive sound tracks for focus and concentration.

By the way, I first fell in love with the elegance of inner voicings while studying classical piano. Because I couldn't play very fast, I had the opportunity to hear every note clearly. When played at normal speed, the inner voicings are usually obscured because the mind focuses on the melody, which is usually the highest-pitched line.

Here's an exaggerated yet interesting illustration of the effect of extraneous auditory information coming into the brain: play two different recordings of music at the same time. Try to just sit there for a minute before reaching for the volume dial or sledgehammer. Chances are your reflex will be to immediately change the sonic environment. Why? Your brain gets confused with too much information at the same time. Even our most highly evolved personal computers will crash with too much random input.

A final thought on this process of "weeding." I have been told on numerous occasions that the pieces that feature inner voices seem to speak to listeners' inner voices. As trite as it may sound, there have been too many correlations between our listeners' favorites and the pieces we have "thinned out" to be coincidental.

SONIC ISOMETRICS

Sonic isometrics is a term I've created to explain the process of alternating simple and complex auditory data to the brain. I use the term *isometrics* for two reasons. First, its definition pertains to having equal quality of measure.

Second, its popular connotation is the use of our own strength against itself to build muscle or create release. Psychoacoustically, I attempt to accomplish both goals with this sonic technique. Alternating simple and complex auditory data to the brain can be done in numerous ways. Let me explain the rationale behind the concept.

When I began working with the Arcangelos Chamber Ensemble in 1996, it was my first opportunity to apply psychoacoustics to a classical music environment. I immediately noticed the harmonic richness of vibrating strings and woodwinds. They sound dense and rich, like the best European chocolate. Additionally, I found the intricacy of classical contrapuntal harmonies to run the gamut from elementary to ultimate complexity. When harmonics and harmony are combined, a significant amount of complex information is being sent to the cortex for translation and interpretation.

From my study of the brain, I know that it is the quintessential computer. Awake or asleep, the brain constantly deciphers millions of bits of minutiae. Music and sound are perceived in many different areas of the brain. Rhythm is tracked by the cerebellum, melody is handled by the temporal lobes on both sides of the brain, and the interpreting of notes takes place on the right side of the brain (corresponding to areas on the left that handle language).[2] The *whole* brain is working as it interprets incoming auditory streams of information. What occurs to me is that this data stream can be filled to the brim, or it can be thinned out a bit. Why lessen the amount of data? Fatigue.

You might wonder, *Can the brain get tired?* Have you ever suffered a sense of brain fade or brain fatigue? I certainly have, especially after intensive thinking. This is the time when someone says, "Let's take a break for ten minutes."

I've learned that the reason we sleep is not necessarily because the body is in need of rest. Rather, the mind needs to slow down. Think of a gigantic network computer system that must go off-line for a period of time every day to update and houseclean . . . Doesn't it make sense that the brain would do the same? The brain is an unfathomably powerful organ. We could probably think ourselves to oblivion given half the chance!

Because the brain can fatigue from too much too fast, maybe we should lessen the load. What takes place when we send a lot of sound and then a little, and then a lot and then a little? *A lot of sound* can be defined in terms of density of orchestration or arrangement, amplitude, or complexity

of harmonic structure. *Density of information* is the key concept here.

I believe that by alternating complex sound (that has abundant material to be processed) with simple sound, multiple reactions take place:

- *The brain is energized.* The process of tension and release affects all organs and muscles. Why would the brain be different?
- *Habituation is broken.* When the brain deciphers patterns, simplistically speaking, it goes into autopilot, turning greater attention to other activities. Sonic isometrics helps us focus by not allowing a pattern to emerge. In baseball, the change-up pitch keeps the batter off balance, unhabituated. Habituation diminishes alertness.
- *The muscles of the middle ear are exercised* by continually readapting. Strengthening these muscles helps cantilever the three bones of the middle ear, thereby increasing the delivery of a full spectrum of sound from the eardrum to the cochlea. The fuller the spectrum of sound we hear, the more stimulation the brain receives.

  How to achieve sonic isometrics? Lawrence and I experimented endlessly with this concept. We arrived at two different approaches.
- *Interludes.* Here we sandwiched nature sounds and simplified, rubato melodies played by one or two instruments between fully orchestrated movements; we were alternating simple sound and complex sound data. In track 4 of the CD, Vivaldi's Largo from the Viola d'Amore Concerto in D Minor, notice how the melody of the movement is played in rubato—nonstructured spaciousness prior to the regimentation of the movement's rendition. We thought about contrasts: open/closed, dense/spacious, tension/release. After the movement is played, we go back to simple sound space and close the piece with nature and simplified melody.
- *Rearrangements.* For an example of this second approach to sonic isometrics, go to track 3, the Adagio from the Concerto Grosso Opus 6, no. 8 by Corelli. Everything is kept in the musical domain without the simplicity of nature sounds; instead, *arrangement of instrumentation* and melody are used to accomplish the same thing. In this selection, the first three minutes of Corelli's concerto is played by the full chamber ensemble. We then segued into piano, violin, flute, and cello. Notice the lightness and spaciousness of the sound. We attempted to create a big breath, a lot of air around each line and instrument. This provides room to think, feel, rest, fall between the cracks. When there

> is a wall of sound, regardless of its beauty or melody, another function is served. Complex sound, for me, is all-encompassing; it demands fuller attention. With simple sound, there is room for other things to occur. (Also refer to track 7, Interlude from Dance of the Blessed Spirits.)

Notice that at minute five, the entire ensemble returns. Now there is much more information for the brain to process. This is therefore an example of complex-simple-complex.

The technique of sonic isometrics is based on intuition. I know of no scientific basis for the concept. Judging from the feedback I have received, however, it is an effective device, and I believe that this effectiveness ultimately will be clinically verified. I eagerly await and welcome your innovative arrangements of this concept in the future.

CONTOURS

Gradual changes in tempo and shifting dynamics (amplitude, panning) help offset the brain's process of habituation. I call this process *contours.*

As I discussed under "Entrainment" in this chapter, Lawrence and I went out of our way not to have our ensemble play metronome perfect. The human body doesn't have a metronome, and that level of rigidity in rhythm sets up a subtle conflict with our organic inner rhythms. The entrainment tug-of-war is between our desire to go to the music and, conversely, to resist it. To win the tug, it is best to match the body's natural tempo. While we needed to stay periodic and regular, to be entrainment effective, we often created a click track that the players worked to in the studio. Very gradually, we sped up and slowed down. The purpose was to keep the brain actively involved. If it senses a pattern that it can count on, it will turn its attention elsewhere. As I have discussed, habituation is a desirable state for deep relaxation applications. However, for attention and mental enhancement, look to maintain rapt attention.

We did the same with volume or panning dynamics as with rhythmic contours. *Subtlety* is the best way to maintain musical integrity without sounding contrived. Again, the purpose of contours is to keep the brain engaged in the process of active listening. Is your goal an active brain or a sleepy brain? Pick the times you want to influence the brain through rhythmic or dynamic contours accordingly. (Track 1 is a great example of dynamic panning that encourages active listening.)[3]

NATURE SOUNDS

I often use the sounds of nature in my work. If used sensitively and with intention, they can enhance any project. If used sloppily, they sound fabricated and will cheapen your efforts. Incorporating nature sounds into a psychoacoustic sound track can be a time-intensive project. I've discovered that in order to use these sounds effectively, I must commit as much time as it takes to manicure every sound on a multitrack recording. To do anything less creates a product that sounds substandard. What's the appeal of these sounds to me? They serve a number of psychoacoustic purposes.

Refer to tracks 1, 4, and 12 on the CD.

- *Psychological.* Underneath our stylish clothes, we humans are animals too. We respond on a very primal level to the sounds of the earth, sky, and water. The use of gentle nature sounds makes us feel both safe and familiar. They're also fun; a great duck at the right place can be very funny! These are good states to create when working with music for healing.
- *Resonance.* Nature sounds, like all other sounds, have definite frequencies. I find that they cover the spectrum of sound. I use them mostly for high-frequency effect. Crickets, wind, and rain can help create the sonic environment that charges the nervous system. I do this in a very dronelike way so it fades into the background and listeners hardly even know it is there. Yet the frequencies are still being perceived by the brain. There are low-frequency sounds as well. You will have to build your own library of sounds by either recording them yourself or buying them from sound companies that specialize in licensed sound effects.
- *Entrainment.* Nature sounds can be used to entrain or to take a listener completely out of time. The sounds of ocean or lake waves are very effective in creating a rhythmic trance. You must thus pick your waves carefully for their speed. Conversely, nature sounds are wonderful in creating a totally rubato effect if you are looking to take your listeners out of time. This depends on the intention of the project. Think of nature sounds as part of your sound palette.
- *Drone.* Because of the drone quality of many nature sounds, they are perfect for masking binaural beat frequencies or other sounds in your track that are not necessarily pleasing to the ear. Also, as drones, these

sounds help in interludes when I want lots of space between rubato, simplified melody lines.

A final note on nature sounds: take the time to do them right. Otherwise, leave them outside.

SONIC NEUROTECHNOLOGIES (SNT)

After reading chapter 15, you should have a good understanding of the two basic avenues of application-specific sound processing. When considering binaural beat frequencies or filtration and gating (FIG) for your project, two questions arise: *Which SNT serves your purpose?* And, more important, *whom will you collaborate with?*

As an ethical musician, I urge you not even to think about creating the protocols of these technologies yourself unless you are a psychologist, neurologist, or licensed therapist. These psychoacoustic sound treatments can have profound effects. Just because we can create these effects as musicians does not mean we are equipped for the outcome. SNTs fall into the category of frequency medicine and should be honored as such. Rule of thumb: collaborate with experts in the field.

When I work with these technologies, they become an integral part of my project plan. Everything creative is planned around the SNTs. This is the only way to emerge with a congruent product. When I coproduced *Sound Body Sound Mind,* our binaural frequency composer was the internationally respected brain wave biofeedback authority Anna Wise (1950–2010). Before we began our musical structure, she created a literal blueprint of four binaural frequencies that changed at regular intervals. Her graphic layout took twenty feet of horizontal paper. It was against this backdrop of her planned brain wave journey that we orchestrated the rest of the album.

Likewise, we worked hand in hand with the protocol team that created The Listening Program. This eight-CD program, designed to retrain auditory tonal processing, uses Tomatis-oriented filtration-and-gating techniques. It took us months to create an integrated program of music, nature, and F/G. Our SNT technical protocol team consisted of one psychiatrist clinically trained in F/G by Tomatis, one neurodevelopmental expert, and one speech and language pathologist.

Some SNTs should be relegated to the category of prescriptive sound programs. This means they are sold only in conjunction with therapeutic support. This is especially true with F/G work. On the other hand, I find that binaural beat frequencies are more adaptable to over-the-counter sound. By this metaphor, you see that the effects of these auditory treatments should be taken with the utmost seriousness and sense of responsibility. Use them with caution in your work. Remember, you do not know who will end up with your album in their hands. Therefore, the onus of responsibility rests with you.

SUMMARY: THE ANATOMY OF PSYCHOACOUSTIC MUSIC CREATION

Intention: What do you want to accomplish?
Choice of music: Intended audience? What kind of music is apropos?
Entrainment: Creating pulse in music; being a *rhythmic escort.*
Resonance: High frequencies *charge;* too many low frequencies *discharge.*
Pattern: Simple (habituation); complex (activating auditory cognition).
Simplified melody lines: Does the arrangement serve?
Sonic isometrics: Alternating simple and complex auditory data to the brain.
Contours: Using rhythm, amplitude, and stereo placement to break habituation.
Nature sounds: Tremendous value; take the time to do right!
Sonic neurotechnologies: What serves? Whom will you collaborate with?

In the application of psychoacoustic principles, think:

- Entrainment/resonance/SNTs
- Which brain wave state is most conducive to a particular activity?
- Beta: fast and high; delta: slow and low.
- Use common sense and conscious recognition.
- Think about subtle distinctions.
- Think sonic alchemy.

- Remember the cornerstone of psychoacoustic orientation:

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ENTRAINMENT

To my community of musicians: I look forward to the collective breakthroughs in psychoacoustic music production. This field is positioned for great innovation and recognition. The finer the combination of art and science, the more effective we all will be.

Stay tuned to www.ThePowerOfSound.com for continued evolutions of soundwork.

CHAPTER 19

The Sound and Music Alliance (SAMA)

SAMA acknowledges the timeless bond between sound and life, and honors the indigenous, traditional, historic, scientific and aesthetic wisdom from which sound and music methods, practices, and knowledge evolve.

FROM SAMA MISSION STATEMENT

A bone flute was recently found in France, dating back thirty-two thousand years—evidence that humans have been playing music since the dawn of culture.[1] Ruminations on music by Pythagoras (d. 495 BCE) and Plato (d. 347 BCE) endure, varied functions of sound are memorialized in the Bible, and early *scientific* considerations go back to J. Struthius (1510–1568).[2] Flash forward five hundred years, and music therapy is abundant. High-intensity focused ultrasound (HIFU) offers noninvasive treatment for certain cancers, rhythm becomes a prescription for Parkinson's, there are 270,000 active choirs with 42.6 million people singing in America, and the rattle and drum continue to serve as powerful tools of indigenous sound healers. This legacy, which spans thousands of years and touches almost every culture, gave birth to SAMA in 2008.

These days, there is active exploration and use of benefit-oriented music and sound—from birthing to dying! Human beings certainly know how to create tools, and intentional sound and music as a transformative process is coming into its place in the sun.

How do practitioners of sound vibration—as abundant as air and as soothing *or* destructive as water—self-organize? And why would they, anyway?

ETHICS IS THE KEY

I remember sitting in a circle of colleagues at a New Hampshire sound colloquium in 1993. The consideration of "ethics" was hot in the air. Unfortunately, proprietary interests were too thick, and a formation of ethical standards was lost in the vapors. Fifteen years, however, is not a long time in the overall schema of professional politics and field development. Cohesion, like entrainment, seems to be a natural process . . .

By 2007, it became apparent that the *emerging* field of soundwork had actually come into view and was being noticed by our culture. Publishers sensed the marketplace, and bookshelves were filled with sound healing books of many stripes, benefit-specific products of increased scientific basis were abundant, highly focused training programs were maturing, and schools were beginning to teach year-long survey courses about the power of sonic energy. The nubile field of sound also presented abundant commercial possibilities. As conferences proliferated, some framed the field in a sophisticated manner, of which we are worthy. Other promoters, however, weren't so mindful.

At this time, Lisa Rafel (musician and therapeutic soundworker) and I were on the faculty of a San Francisco sound training program. We compared notes and discovered we were both greatly concerned about the growing velocity of commercial interest in the world of intentional sound and music. We were troubled by the claims of many product manufacturers, teaching programs, and individual practitioners looking to *sell* a customer on the benefits of their offerings, sound or not! Finally, upon seeing a large soundwork confab turned into a carnival environment, Rafel and I were sufficiently chagrined. Could our cherished *emerging* field actually become a commercialized wasteland, inappropriately packaged to the public and pulled into the scrutiny of governmental regulatory agencies?

Amid our concern were increasing numbers of people of all ages, interested in the field—many looking for a new career. Sound will always be a powerful attractor. We noticed the advances in research and material application, the passionate commitment of sound innovators, and the wonderful evolving synergies of new combinations. With a sacred lineage of thousands

of years, professional integrity, and appropriate public presentation, how could the field of soundwork not thrive?

The primary question that surfaced for Rafel and me was, *What would serve to keep the practice and evolution of intentional sound integral?* All the elements were present: a public love affair with music, the thrust of the energy of sound, and the desire for holistic interaction with allied fields! In the public eye, would soundwork be seen as a cheap new trick or a meaningful evolution of an energetic resource with a deep lineage and growing scientific basis?

With these guiding inquiries, our work began. The mission statement says it all. The Code of Ethics and Membership Standards that recognize excellence can be found online:

ThePowerOfSound.com/SAMA

SAMA Mission Statement

- SAMA is an interdisciplinary alliance that promotes our mutual interests in the intentional use and transformative power of sound and music throughout the full spectrum of life cycles.
- SAMA affirms the diversity of disciplines that utilize sound and music and advocates its use in health, education, research, technology, science, and the holistic arts.
- SAMA advances harmonious collegial relationships, ethical behaviors, and multidisciplinary competencies.
- SAMA promotes the professional development and welfare of its members.
- SAMA upholds a code of ethics applicable to its membership.
- SAMA recognizes reputable and responsible sound and music disciplines, educational programs, practitioners, and products.
- SAMA affirms the value of both qualitative and quantitative research.
- SAMA serves its members, the public, institutions, employers, and policy makers through its support of excellence in education, practice, and research.
- SAMA develops educational objectives, programs, curricula and/or continuing education events, in support of our 501(c) 6 status, to provide learning opportunities for those working with music and sound.

- SAMA acknowledges the timeless bond between sound and life, and honors the indigenous, traditional, historic, scientific, and aesthetic wisdom from which sound and music methods, practices, and knowledge evolve.

I include SAMA's basic principles within the 2010 revision of this book because:

> SAMA is the first American professional association of intentional music and sound with a primary focus on uniting a very broad field—including scholars, researchers, writers, musicians, practitioners, and educators—to advance and improve the professional and business circumstances of all members.
>
> I recommend your support and membership in this worthy initiative.
>
> I encourage the inclusion of SAMA's ethical tenets within all aspects of soundwork.
>
> SAMA is indicative of the maturation of the field of soundwork.

I want to participate in the SAMA community. What can I do?

1. Visit SAMA online and get involved.
2. Help SAMA financially. As a nonprofit, the organization's charter membership and other sustaining fundraising drives will be ongoing.
3. Join SAMA (as an organization or individual) as a professional, allied, student, or supporting member.
4. Support organizations and individuals who publicly subscribe to the SAMA Ethical Standards.
5. Volunteer.

For details and social networking for the Sound And Music Alliance,
ThePowerofSound.com/Sama or SoundAndMusicAlliance.org.

ADDITIONAL SOUNDWORK ASSOCIATIONS

There are two other organizations that have come into being between 2001 and 2010. As with SAMA, they're indicative of the network-

ing and self-organizing taking place within the ever-expanding field of soundwork.

- International Association for Music and Medicine (IAMM)
- The National Standards Board for Therapeutic Musicians (NSBTM)

ThePowerOfSound.com/SoundAssociations

EPILOGUE

SHIFTING THE SOUND PARADIGM

This book suggests we hold sound in a new context:

- Sound and music are *nutrients* for the nervous system.
- The auditory mechanism is a mega-portal to the brain.
- Sonic *tools* empower health, learning, and productivity.

The overarching theme of *The Power of Sound* has centered on a new paradigm concerning the nature of sound and the vital importance of the auditory mechanism. Sound, hearing, and human communication are inextricably linked. The ability to perceive a full sound spectrum is a prime necessity for integrated living. With this understanding, sound awareness and intentional application becomes critical.

The writing of this book has encompassed a decade of my life. I believe the conscious selection of soundspace and the ability to accurately perceive it will represent an evolutionary shift. If we think of the human body as an "earth unit"—designed to house the heart, mind, and spirit—ears are standard equipment on all models. If sound is indeed *fuel,* and the ear the *portal,* why is it that our owner's manual is basically blank concerning this important energy component?

Regardless of the reason, those of us involved with psychoacoustics endeavor to shed light on, and to invite further exploration into, this potent energy system. Intentional music and sound tools for the twenty-first-century human are on par with DNA strands, bioengineering, nanotechnologies, and robotics. Mindfully, I have moved from the realm of sound enthusiast to sonic activist. And it seems that parallels between environmental and sonic activism emerge.

SONIC ACTIVISM

The sun provides power and heat, *and* it can burn or debilitate us. We need water to survive, yet too much can drown us. It all comes down to balance. Sound, like other elements, can fuel or deplete us. Given the necessity of increased sound awareness, what is the current state of sound? What are the politics of sound? Who controls the soundspace? Headlines from the Noise Pollution Clearinghouse[1] show that sound awareness is increasing all over the planet. In China, England, India, Korea, Kenya, and New York City, people and governments are taking healthy sound space into consideration as never before. Increasing noise pollution affects the planet's citizenry physiologically and psychologically.

Governments and industry will address the effects of noise pollution on health when sufficient economic factors arise. I predict this follows the trend of legal judgments against American tobacco companies in the impetus: spiraling health care costs for cancer-related treatments. I don't think that noise creates cancer, but I do believe that constant exposure to noise can wreak havoc on the immune system.

The visionary insights of Tomatis were one hundred years ahead of his time. In the year 2010, people are just beginning to awaken to the *physiological* impact of noise pollution. Around the corner lies the awareness of the *psychological* impact of auditory dysfunction.

Sound is ubiquitous. How we use it is our choice. Sound is an ally; it always has been. The question is whether we are ready to embrace it as such. We talk of harnessing solar, wind, and other natural energies. For a fun thought, imagine cars running on energy created by singing drivers. Or cities powered by the recycled sounds of massive telephone networks. Impossibilities, according to the principles of basic physics? Probably so. But sound is also quite low tech. Sound as fuel for the human power grid is as close as your loved one's ear.

HEARTS OPEN WITH GRATITUDE

The *open source* of this field allows each of us to contribute a singularly authentic manifestation of our chosen life paths. Fortunately for us, these people were called, in the same way that we all are tapped, to do something of consequence—of heart, mind, and spirit significance—contributing to the world through the medium of sound.

The soundwork community is an intimate one. When one of us passes,

the loss is accepted, for what else is there to do? However, because of our stage of collective development, we feel the gap, as each of us holds an important piece to an unfolding puzzle.

IN MEMORIAM

The following musicians, drummers, doctors, inventors, and seekers were *very special;* each, with an individual contribution, helped lay a strong foundation on which the modern field of intentional music and sound grows.

With deep gratitude and respect, we acknowledge the extraordinary contributions of:

Sarah "Saruah" Benson, sound healer (1935–2008)
Barry Bernstein, drummer (1954–2009)
Kaye Gardner, composer (1941–2002)
Sir Dr. Peter Guy Manners, modern Cymatics (1935–2009)
Robert Monroe, sound and consciousness (1915–1995)
Dr. Alfred Tomatis, creator of Tomatis Method (1920–2001)

For detailed obituaries, see ThePowerOfSound.com/Memoriam

Glossary

Author's note: Many of these terms have complex definitions corresponding to specific disciplines. The glossary is interpreted from a *soundwork* point of view.

acoustics: An interdisciplinary science focused on the study of sound and hearing.

acoustic nerve: The eighth cranial nerve, concerned with hearing and balance.

air conduction: Sound waves, transferred through air into the external auditory canal and middle ear, causing the eardrum to vibrate and the inner ear auditory mechanism to process.

ambient noise: The total of all pervasive noise in a given environment, other than the noise from the source of interest.

amplitude: The volume of a sound; the extent to which air particles are displaced in response to the energy of a sound.

anechoic chamber: A shielded room in which the boundaries absorb nearly all incidental sound, thereby effectively creating an attenuated sound- or electromagnetic-free environment.

Arcangelos: A chamber ensemble featured on the enclosed album, *Music for The Power of Sound.*

audiologist: A health care professional certified in the science of hearing, auditory and vestibular impairments, and rehabilitation.

audiometer: An instrument measuring the range and sharpness of hearing through controlled measurements of sound through air and bone conduction.

auditory cross dominance: A process whereby a person with right-sided dominance, (i.e., with a leading right hand, right foot, right eye), has a left-leading ear (or vice versa if left-handed).

auditory integration training (AIT): A sound stimulation program developed by Dr. Guy Berard of France.

auditory nerve: The nerve carrying electrical signals from the inner ear to the base of the brain. (See **Vestibulocochlear nerve**.)

auditory perception: How the brain understands and uses the sound it receives.

auditory sequential processing: The ability to link pieces of auditory information together; to remember the order of things heard.

auditory tonal processing: The ability to differentiate between the tones used in language.

basilar membrane: A thin sheet of material that vibrates in response to movements in the liquid that fills the cochlea; the basilar membrane aids in translating sound vibrations into electrical signals.

binaural beat frequencies (BBFs): A neuroacoustical phenomenon that takes place when the brain hears one tone in one ear with a slightly detuned tone in the other. As a means of measuring the difference between these two tones, the brain creates a third "phantom" tone, unheard elsewhere. These auditory processing artifacts were discovered in 1839 by Heinrich Wilhelm Dove.

biological rhythm: Self-sustained cyclic change in a physiological process or behavioral function of an organism that repeats at regular intervals.

bone conduction: The transference of sound waves through reverberations of bone to the inner ear.

bony labyrinth: The cavity in the skull that contains the inner ear mechanism, consisting of the vestibule, semicircular canals, cochlea, and perilymph.

brain waves: The electrochemical activity of the brain that produces electromagnetic wave forms detectable with an electroencephalograph. Beta waves (14–35 Hz), alpha waves (8–14 Hz), theta waves (4–8 Hz), delta waves (.5–4 Hz).

central auditory processing: The processing of sound along the auditory neural pathways from the cochlea to the brain and using that sound in the brain's auditory centers.

cerebral cortex: That surface of the cerebrum where sensory information is processed. The cerebral cortex is a layer of unmyelinated neurons (the grey matter) and plays a key role in memory, attention, perceptual awareness, thought, language, and consciousness.

cilia: Delicate sensory cells, resembling hair-like projections, located in the organ of Corti region of the cochlea. Connecting with nerve fibers, inner ear cilia cells transport airborne vibrations from the inner ear to the brain.

circadian rhythm: A self-sustained biological rhythm that in an organism's natural environment has a period of approximately twenty-four hours.

cochlea: Coiled like a snail's shell, this auditory portion of the inner ear contains the organ of Corti, from which eighth-nerve fibers send hearing signals to the brain. (See **inner ear.**)

compression and rarefaction: A process involving the alternating density of molecules in the air and how information is passed.

contours: Gradual changes in tempo and shifting dynamics (amplitude, panning, etc.) to offset habituation of the brain.

decibel (dB): The measurement of the volume or loudness of a sound.

detuning: A process used in the creation of binaural beat frequencies whereby simultaneous stereo tones are slightly changed (i.e., sound frequencies differ by a prescribed number of Hz from each other).

drone: A harmonic or monophonic effect where a note or chord is continuously sounded throughout a piece of music.

eardrum: The thin membrane, known as the tympanum, that separates the outer ear from the middle ear. Its function is to transmit sound from the air to the ossicles inside the middle ear.

earmuffs: Special ear protectors designed for protection from loud sound.

earplugs: Noise protection made of foam, silicone, or wax.

Electronic Ear: An essential component of the Tomatis Method created by Dr. Alfred Tomatis. This device, interconnected between a tape or CD player and the listener's headphones, has the capacity to filter the sound through two channels with different settings. A gating mechanism alternates the sound between the channels when it reaches a specific intensity. The Electronic Ear is designed to educate the ear to its full functions as a receptor, a mechanism to make subtle discriminations, and an energy generator.

entrainment: A changing of the rate of primary body pulses (i.e., brain waves, breath, or heartbeat) from one speed to another, caused by the organ *falling into step* with a dominant and periodic external stimulus (rhythm).

filtration: A removal of specific frequencies.

filtration/gating techniques (F/G): A methodology devised by Dr. Alfred Tomatis to retrain and strengthen the auditory mechanism through the gradual filtration and reintroduction of the lower range of music (sometimes up to 8,000 Hz) and the use of random sonic events (gating).

form: The structure of a musical composition.

frequency: The periodic speed at which an object vibrates; the number of vibrations within a specified period of time.

gating: Refers to a random sonic event, often accomplished through the electronic

processing of a soundtrack so it unexpectedly jumps between high and low frequencies or variances in amplitude.

GIM: The Bonny Method of Guided Imagery and Music.

golden section: Also known as the "golden ratio" and the "golden mean." A specific geometric proportion seen in Egyptian pyramids (thirteenth century BCE), the Parthenon at Athens (fifth century BCE), artwork, and nature.

harmonics: A series of tones vibrating above a fundamental note. Known as overtones or partials, these softer tones are pure and clear sounds.

harmony: The pleasant combination of different notes of music played simultaneously.

hearing: The subjective and passive response to sound.

hearing loss: Any reduction in the normal way a person hears.

Hertz (Hz): The international standard term for a unit of frequency measured in cycles per second (cps). Named for the German physicist Heinrich Hertz.

high frequency: Any tone that has more cycles per second; generally anything over 1,000 Hz.

infrasonic: Sound waves below 20 Hz.

inner ear or cochlea: Herein the vibration of sound is converted into electrical signals. The vestibular system also resides here. The semicircular canals and the vestibular sacs are the upper part of what is known as the bony labyrinths of the inner ear. (See **cochlea.**)

instrumental colors: In Western music, the study of instrumental color is known as orchestration.

iso principle: *Iso* means "equal." Applied to therapeutic music, the iso principle is a technique of initially matching the mood (or tempo) of the music to that of the listener and then slowly changing that mood, tempo, or timbre.

laterality: Lateral preference is the predominant use of one side of the body over the other in voluntary motor acts.

listening: Active (vs. passive) hearing.

lithotripsy: The dissolution of kidney and pancreatic duct stones with externally applied, focused acoustic wave bombardment.

loudness (amplitude): A perception of sound strength; a psychological impression.

low frequencies: Any tone that has fewer cycles per second; generally anything up to 1,000 Hz.

melody: A linear succession of musical tones. The primary element we hear in a composition.

middle ear: A hollow region directly behind the eardrum and external to the oval window of the cochlea. The middle ear is tiny, only about two milliliters in volume. It houses three small bones, known as the hammer (malleus), anvil (incus), and stirrup (stapes), and two tiny muscles (the tensor tympani and stapedius).

music therapy: Music therapy is both an allied health profession and a field of scientific research that studies correlations between the process of clinical therapy and biomusicology, musical acoustics, music theory, psychoacoustics, and comparative musicology. It is an interpersonal process in which a trained music therapist uses music and all of its facets—physical, emotional, mental, social, aesthetic, and spiritual—to help clients to improve or maintain their health.

neurodevelopment: The development and organization of the central nervous system, comprising processes that generate, shape, and reshape the nervous system, from the earliest stages of embryogenesis to the final years of life.

noise: Derived from the Latin word *nausea,* meaning "seasickness"; any loud, unmusical, or disagreeable sound.

noise-induced hearing loss (NIHL): A diminution of hearing capacity due to repeated or extended exposure to dangerous noise levels, resulting in damaged cilia hair cells in the cochlea.

nonperiodic: A nonregular pulse and frequency.

organ of Corti: Located in the inner ear of mammals, this cochlear region contains auditory sensory cells, or "hair cells," that transmit sound waves from the ear through the auditory nerve to the brain.

ostinato: In music, a short melodic phrase repeated throughout a composition, sometimes slightly varied or transposed to a different pitch; also known as pedal point.

outer ear: Consists of the pinna (auricle), auditory canal (meatus), and eardrum (tympanic membrane). Also known as the external ear, the outer ear gathers sound energy and focuses it on the eardrum.

oval window: Vibrations that come into contact with the oval window have first traveled through the three ossicles of the middle ear and are enroute to the inner ear. The oval window vibrates, transmitting sound frequencies into the cochlea.

perilymph: An extracellular fluid that fills the outer tubes running through the cochlea. The ionic composition of perilymph is comparable to plasma and cerebrospinal fluid.

period: The time that elapses before a rhythm starts to repeat itself.

periodicity: The quality of repeating precisely the same pattern on a regular basis.

pitch: The perceived fundamental frequency of a sound, pitch signifies how high or low a tone sounds to the ear.

psychoacoustics: The study of the perception of sound, including how we listen, our psychological responses, and the physiological impact of music and sound on the human nervous system.

resonance: A resonance is the sound that is produced by an object when it vibrates at the same rate as the sound waves from another object. The effect of one vibration on another. The frequency at which an object most naturally vibrates.

resonant system: When two or more objects have similar vibratory characteristics allowing them to resonate at the same frequency.

resonate: To re-sound. Something external sets something else into motion or changes its vibratory rate.

rhythm: Periodic movement. The organization of music in time using long and short note values.

SIAD: Stress-induced auditory dysfunction. Term coined by author.

semicircular canals: Three half-circular, interconnected tubes located inside each ear. These curved tubes contain fluid, the movement of which makes us aware of turning sensations as the head moves.

sensorineural hearing loss: Hearing loss in which the root cause lies in the vestibulocochlear nerve, the inner ear, or central processing centers of the brain.

sonic isometrics: Term coined by author to explain the process of alternating simple and complex auditory data to the brain.

sonic neurotechnologies (SNTs): Phrase coined by author to describe the precise mechanical manipulation of sound waves to bring about desired changes in psyche and physical body.

sonorous body: Anything capable of producing sound.

sound: A sensation caused by an object or objects that vibrate. Anything that creates the sensation of hearing.

sound stimulation: The excitement of the nervous system by auditory information.

sound stimulation auditory training (SSAT): A precise application of electronically processed sound, through headphones, to retrain the auditory mechanism to take in a wider spectrum of sound frequencies.

sound therapy: Using the principles of resonance, entrainment, and vibration to effect changes in tissues and organs. Primarily neurologically oriented.

sound wave: Alternating low- and high-pressure areas, moving through the air, that are interpreted as sound when collected in the ear.

soundwork: The use of sound waves (heard or unheard) as a therapeutic modality; intentional music and sound for the enhancement of functioning.

sympathetic vibration: The natural ability of a substance such as metal, wood, air, and living flesh and bone to vibrate to a frequency imposed from another source; a harmonic phenomenon where a passive string or vibratory body responds to external vibrations to which it has a harmonic likeness.

spectrum: A sound wave's resolution into its components of frequency and amplitude.

stapedius: At just over one millimeter in length, the stapedius is the smallest skeletal muscle in the human body. Its purpose is to stabilize the smallest bone in the body, the stapes. The stapedius muscle dampens the ability of the stapes to vibrate and protects the inner ear from high noise levels, primarily the volume of one's own voice.

tectorial membrane: Located in the organ of Corti, a thin strip of membrane in contact with cilia sensory hair cells, which is moved by sound vibrations, producing nerve impulses.

tensor tympani: The larger of the two muscles of the tympanic cavity (the other being the stapedius), the tensor tympani is contained in the bony canal above the osseous portion of the auditory tube. It is attached to the malleus.

timbre: Tone color or quality of a musical note, sound, or tone that distinguishes different types of sound production (e.g., trumpet vs. violin).

tinnitus: Ringing in the ear or noise sensed in the head. Tinnitus is the perception of sound within the human ear in the absence of corresponding external sound.

Tomatis, Alfred A. (1920–2001): French ear, nose, and throat physician, sound researcher, inventor, author. Creator of the Tomatis Method. Considered by many to be the "Einstein of the ear."

Tomatis Effect: "The voice can only reproduce sounds that the ear can hear." This statement is the basis on which the French Academy of Medicine and Academy of Science named one of the many discoveries of Alfred Tomatis.

Tomatis Method: A noninvasive program of sound stimulation, audio-vocal activities, and consultation. It is used to enhance abilities or overcome problems that are listening related, such as speech and language, learning, attention, and communication, among others. The method was developed by Alfred Tomatis over fifty years ago and has been used throughout the world with both children and adults.

tone: A sound of definite pitch.

tuning fork: A small steel instrument with two prongs that sounds a certain fixed tone in perfect pitch when struck.

tympanum: Also known as the eardrum. Membrane separating outer ear from middle ear.

ultrasonic: Sound waves above 20,000 Hz, which human beings cannot hear.

vagus nerve: The pneumogastric or tenth cranial nerve. It is called the vagus (wandering or vagabond) nerve because it meanders through the thoracic and abdominal cavities, conveying sensory information about the state of the body's organs to the central nervous system.

vestibular apparatus: The vestibule and three semicircular canals are part of the inner ear. These structures work with the brain to sense, maintain, and regain balance and a sense of where the body and its parts are positioned in space.

vestibulocochlear nerve: Also known as the auditory or acoustic nerve, the vestibulocochlear nerve is actually the eighth *pair* of cranial nerves. Concerned with hearing and balance, the eighth cranial nerve transmits sound and equilibrium information from the inner ear to the brain.

vibration: A rapid rhythmic motion back and forth, vibration refers to mechanical oscillations about an equilibrium point.

waves: A disturbance that propagates through space and time, usually with transference of energy.

wavelength: Distance between the peaks (consecutive corresponding points of the same phase) of successive sound waves.

wave motion: The phenomenon of a transfer of energy, or information, from one source to another.

white noise: Noise whose energy is uniform over a wide range of frequencies. Analogous in spectrum characteristics to white light.

The author gratefully acknowledges the following sources used in the compilation of this glossary:

Answers.com
Britannica.com
Don Campbell
Google.com/health
Medical-dictionary.com
thefreedictionary.com
Medterms.com
Merriam-webster.com
Science.education.nih.gov
Thefreedictionary.com
Wikipedia.com
Wordnetweb.princeton.edu/perl/webwn

THEPOWEROFSOUND.COM

With the emergence of digital distribution, information is now easily available in multiple formats. *The Power of Sound* has a companion website designed to be used with the hard-copy book.

Prepublication, this 2010 edition started with six hundred pages. Hundreds of pages of the original manuscript are now found online. In this dynamic medium, the website moves beyond archival and backstory function. It additionally provides a trove of live links to additional research and resources. ThePowerOfSound.com also actively allows for the explorations, attempts, and triumphs of *soundwork* to continue updating. In other words, the inquiry of this book doesn't end!

Optimal use of the book/website combo:

- If you are reading on a wireless reading device (i.e., Kindle, iPad, etc.), you have both the book and website at your fingertips. Now, we're talking twenty-first-century reading!
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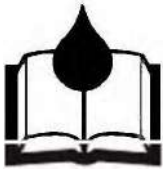
- If you do not have a computer handy while reading, keep a notepad of website pages that have been referred to in your chapters, and access the website when you are able.

One way or the other . . . use this digital companion! *The Power of Sound* second edition was written and compiled knowing that both mediums would be of service.

FIND IT ON THEPOWEROFSOUND.COM

- Research abstracts
- Interviews with leading soundworkers
- Neurodevelopmental Auditory Training: The Work of Robert J. Doman Jr.
- The Bonny Method of Guided Imagery and Music (GIM)
- Drumming as Meditation in Iraq (Christine Stevens)
- Stress-Induced Auditory Dysfunction
- Tomatis: Revising the Map of the Musician's Odyssey
- The Birth of a Sound Therapy (Alexander Doman)
- Music Therapy
- Expanded glossary
- Soundwork Resources
- Contact information for featured organizations and individuals
- Detailed obituaries of leading soundwork figures.
- Frontiers of Soundwork: a summary of significant soundwork events since 1787
- The Sonic Activist: a networking source for those interested in sonic activism
- Soundwork Resources: a comprehensive reference list of people and organizations involved in soundwork
- Information about Joshua Leeds's schedules of seminars and appearances
- Blogs by Joshua Leeds and guests

Sound Remedies Catalog



The focus of the Sound Remedies Catalog is the emerging field of soundwork, broadly defined as the intentional creation and employment of music and sound for specific applications. The catalog contains categorized lists of music and sound programs, videos, recommended reading, and resources in the following categories:

- Children
- Creativity
- Exercise/Fitness
- Massage/Bodywork
- Relaxation/Stress Reduction
- Therapeutic Applications
- Concentration/Accelerated Learning
- Healing and Balance
- Office/Treatment Room Ambience
- Sleep
- Transitions: Cradle to Grave

New programs are constantly being reviewed and added. Categories will continue to grow as psychoacoustic programs of high aesthetic value and effective sonic technologies are produced.

Most programs in the catalog have *not* been created for entertainment purposes. Rather, they've been produced with highly specific methodologies and outcomes in mind. Be it for health, learning, or productivity, these "sonic tools" are designed for the enhancement of human function.

The complete catalog can be viewed online at Sound-Remedies.com.

Music for The Power of Sound

CD Track Listing

Music for The Power of Sound is specially orchestrated classical music selected from the *Sound Health* and *Essential Sound* series, produced by Joshua Leeds.*

Tracks 1–12 are performed by the Arcangelos Chamber Ensemble; track 13 is performed by the Apollo Chamber Ensemble.† The purpose of this CD is twofold: to provide sonic ambience conducive to relaxation and learning and to illustrate concepts contained within this book (see referral page numbers in Track Listings on p. 273).

While there are no sonic neurotechnologies (filtration/gating or binaural beat frequencies) used in these selections, the natural principles of resonance, entrainment, and pattern identification inform all arrangements. Putting technical explanations aside, *Music for The Power of Sound* is a modern embodiment of the age-old musical goal: beautiful sounds for enhancement, balance, and well-being.

**The Sound Health Series* was co-produced by Richard Lawrence.

†The Apollo Chamber Ensemble features Lisa Spector, pianist.

TRACK NO.	REFERRAL PAGE NOS.	TITLE (COMPOSER)	(TIME) (SOUND HEALTH ALBUM)
1	248, 249	Divertimento #1 in D Major K136, with interlude (Mozart)	(5:10) (Motivation)
2	TPOS.com	Clarinet Quintet in A Major K581, theme and variations (Mozart)	(5:55) (Motivation)
3	236, 247	Adagio from Concerto Grosso Opus 6, no. 8 (Corelli)	(6:19) (Relaxation)
4	247, 249	Largo/Viola d'Amore Concerto in D Minor, with interlude (Vivaldi)	(5:36) (Learning)
5	236	Gymnopédie #1, with interlude (Satie)	(5:17) (Inspiration)
6	241, 244	Fourth Symphony, Poco Adagio (Mahler)	(7:55) (De-Stress)
7	248	Interlude from Dance of the Blessed Spirits (Gluck)	(2:10) (Inspiration)
8	236, 240	Largo from Oboe Concerto in B Flat, with interlude (Vivaldi)	(4:10) (Learning)
9	236	Oboe Quartet in F Major K370 Allegro (Mozart)	(4:17) (Motivation)
10	236, 243	Largo from Concerto no. 3 for Two Violins (J. S. Bach)	(5:52) (Concentration)
11	236	Sunshine Suite, Third movement (Lawrence)	(1:49) (Productivity)
12	115, 245, 249	Allegro Assai from Violin Concerto no. 2 in E Major (J. S. Bach)	(5:15) (Learning)
13	226, 235	Flute Sonata in Eb Major, Allegro, and Suite in B minor, Polonaise (Bach) Gymnopédie No. 1 and 3 (Satie)	(13:00) (ReSet Therapeutic Series)

NOTES

INTRODUCTION

1. Campbell, *Mozart Effect.*
2. Haas, and Brandes, *Music that works.*
3. National Institutes of Health, "Noise and Hearing Loss" (consensus development conference statement, January 22–24, 1990).
4. Billie M. Thompson, and Susan R. Andrews, "The Emerging Field of Sound Training," *Engineering in Medicine and Biology* 18, no. 2 (March–April 1999): 92.
5. Robert J. Doman Jr., "Sensory Stimulation," *Journal of the National Academy of Child Development* 1, no. 1 (1980).

CHAPTER 1. WHAT IS SOUND?

1. Hewitt, *Conceptual Physics,* 342.
2. Berendt, *Nada Brahma,* 18.
3. Tame, *Secret Power of Music,* 206.
4. Ibid., 33.
5. Ibid., 33–68. Synchronistically, the loss of the five-thousand-year tradition of sound use to Western music took place within the period that also resulted in the modern makeover of China. Current concerts include *Sacred War Symphony* and *The Red Detachment of Women.*

CHAPTER 2. THE PHYSICS OF SOUND

1. Helmholtz, *On the Sensations of Tone,* 1.
2. Hewitt, *Conceptual Physics,* 322.
3. Ibid., 340.
4. Hall, *Musical Acoustics,* 6.
5. Helmholtz, *On the Sensations of Tone,* 8.
6. Carlson, *Physiology of Behavior,* 182.
7. Hewitt, *Conceptual Physics,* 342.
8. Seth J. Putterman, "Sonoluminescence: Sound into Light," *Scientific American* 272, no. 2 (February 1995): 46–51.

CHAPTER 3. THE MECHANICS OF HEARING

1. Tomatis, *Ear and Language,* 175. Dr. Alfred Tomatis has proposed an alternative concept about the pathway of sound and the role of the ossicles, however. He believes that sound is not transferred through the ossicles, as is the common belief—referred to as the Helmholtz-Békésy concept. Tomatis states, "The peripheral bone that surrounds the tympanic membrane, especially in the lower area, conducts the sound toward the inner ear." Essentially it is the entire bony structure of the middle-ear chamber—not the ossicles—that transfers sound (vibrates) to the inner ear; the primary function of the ossicles is as a muting device to protect the inner ear from dangerously loud sounds.
2. Bradford Weeks, "The Therapeutic Effects of High-Audition Music and Its Role in Sacred Music," in *About the Tomatis Method,* ed. T. Gilmore (Toronto: Listening Centre Press, 1989), 167.
3. Carlson, *Physiology of Behavior,* 183–90.
4. Weeks, "Therapeutic Effects of High-Audition Music," 167.

CHAPTER 4. RESONANCE, ENTRAINMENT, AND PATTERN IDENTIFICATION

1. Hewitt, *Conceptual Physics,* 346.
2. Hall, *Musical Acoustics,* 233.
3. Hewitt, *Conceptual Physics,* 348.
4. Ibid.
5. Cole, *Sympathetic Vibrations,* 265.
6. Ibid., 265.
7. McClellan, *Healing Forces of Music,* 21.
8. Hewitt, *Conceptual Physics,* 346.
9. Cole, *Sympathetic Vibrations,* 264.
10. M. H. Thaut, G. P. Kenyon, M. L. Schauer, and G. C. McIntosh, "The Connection between Rhythmicity and Brain Function," *Engineering in Medicine and Biology* 18, no. 2 (March–April 1999): 101.
11. Jonathan Goldman, "Sonic Entrainment," in *MusicMedicine,* ed. Ralph Spintge (St. Louis, Mo.: MMB, 1992), 194–208; Goldman, "Sonic Entrainment," in *Music: Physician for Times to Come,* ed. Don Campbell (London: Quest Books, 1991), 217–33.
12. Leonard, *Silent Pulse,* 13.
13. Bentov, *Stalking the Wild Pendulum,* 31.
14. Ibid., 29.
15. F. Holmes Atwater, *The Monroe Institute's Hemi-Sync Process: A Theoretical Perspective* (Faber, Va.: The Monroe Institute, 1988).
16. Thaut et al., "Connection between Rhythmicity and Brain Function," 107.

CHAPTER 5. FREQUENCY MEDICINE: THE WORK OF ALFRED TOMATIS

1. Timothy Gilmore, Paul Madaule, and Billie Thompson, *About the Tomatis Method* (Toronto: Listening Centre Press, 1989), 7.
2. Ibid., 214.
3. Ibid., 7.
4. Tomatis, *Conscious Ear,* 12–35.
5. Ibid., 42.
6. Thompson and Andrews, "The Emerging Field of Sound Training," 90.
7. Ibid., 91.
8. Billie M. Thompson, "Afterword," in Tomatis, *Ear and Language,* 200.
9. Thompson and Andrews, "Emerging Field of Sound Training," 93.
10. Tomatis, *Conscious Ear,* 140–59.

CHAPTER 6. A NEW AWARENESS OF SOUND

1. Fred Schwartz, M.D., "Music as Anesthesia," in *Sonic Alchemy: Conversations with Leading Sound Practitioners,* ed. Joshua Leeds (Sausalito, Calif.: InnerSong Press, 1997), 79–88.
2. T. Wigram, "The Physical Effects of Sound," *British Society for Musical Therapy Bulletin,* no. 7 (Autumn 1989): 15.
3. Thompson and Andrews, "Emerging Field of Sound Training," 92.
4. Joshua Leeds, ed., *The Listening Program Guidebook* (Ogden, Utah: Advanced Brain Technologies, 1999), 78.
5. Tomatis, *Ear and Language,* 129.
6. *Merriam-Webster* (Springfield, Mass.: Merriam-Webster Incorporated), 1989.
7. Robert J. Doman Jr., "Dominance and Emotionality," *Journal of the National Academy for Child Development*2, no. 2 (1982). A reprint of this article can be found on the website of the National Association for Child Development (www.nacd.org).
8. Alfred Tomatis, interview in *About the Tomatis Method,* ed. Billie Thompson (Toronto: The Listening Centre Press, 1989), 210.
9. Reinhard Flatischler, "The Influence of Musical Rhythmicity in Internal Rhythmical Events," in *MusicMedicine,* ed. Ralph Spintge (St. Louis, Mo.: MMB Music, 1992), 241–48.
10. Schafer, *Soundscape,* 227.
11. Flatischler, *Forgotten Power of Rhythm,* 93.
12. Ibid., 226.
13. Flatischler, *Forgotten Power of Rhythm,* 242.
14. Schafer, *Soundscape,* 227.
15. Flatischler, *Forgotten Power of Rhythm,* 242.

16. Ibid., 248.
17. Ibid.
18. Wise, *High Performance Mind*, 3.

CHAPTER 7. SONIC SAFETY

1. Robert W. Wilmott, "Teenagers and Music-Induced Hearing Loss," *The Journal of Pediatrics* 155, no. 4 (October 2009): 550–52.
2. Claudia Kalb, "Our Embattled Ears: How to Protect Yourself," *Newsweek* 130, no. 8 (August 25, 1997): 75–77.
3. Mary Jo Burtka and Kathleen L. Yaremchuk, "Variations and Pitfalls of Noise-Induced Hearing Loss," *Hearing Loss* (May–June, 1997).
4. House Ear Institute website (www.hei.org).
5. Melinda Beck, "A Key for Unlocking Memories," *The Wall Street Journal,* November 16, 2009.
6. www.imnf.org.
7. B. J. Fligor and L. C. Cox, "Output Levels of Commercially Available Portable Compact Disc Players and the Potential Risk to Hearing," *Ear & Hearing:* (2004): 513–27.
8. B. J. Fligor, and Terri Ives, "Does Earphone Type Affect Risk for Recreational Noise-Induced Hearing Loss?" www.heating conservation.org (2006).
9. Journal of Pediatrics. (quote came from downloaded "Hearing Loss Related to MP3s and iPods").
10. Working group from the Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR) of the Directorate-General for Health and Consumers of the European Commission. (http://ec.europa.eu/health).
11. ref: iPod Safety: Preventing Hearing Loss in Teens (Alice Park) Time.com.
12. B. J. Fligor in interview with AAA. "Stereos, MP3s, and Hearing Loss."
13. Brian Fligor, ScD, director, Diagnostic Audiology, Children's Hospital, Boston; instructor, Harvard Medical School.
14. www.apple.com/sound.
15. Apple sued over iPod-related hearing loss. http://arstechnica.com/old/content/2006/02/6100.ars.
16. Burtka and Yaremchuk, "Variations and Pitfalls of Noise-Induced Hearing Loss."
17. Stephen A. Falk and N. Woods, "Hospital Noise Levels and Potential Health Hazards," *New England Journal of Medicine* (October 1973): 774–80.
18. U.S. Department of Labor, Occupational Safety and Health Administration, *Occupational Noise Exposure: Hearing Conservation Amendment, Part III, Federal Register* 46 (1981): 4078–179.
19. Kalb, "Our Embattled Ears," 75.

CHAPTER 8. NEUROSCIENCE AND MUSIC

1. Helmholtz, *On the Sensations of Tone as a Physiological Basis for the Theory of Music,* 1885.
2. Juan Roederer, "Music and the Evolution of Human Brain Function," in Haas and Brandes, *Music that works,* 195.
3. Thaut, *Rhythm, Music and the Brain,* viii.
4. E. Niedermeyer and F. Lopes da Silva, *Electroencephalography,* 4th ed. (Baltimore: Williams & Wilkins, 1999), 1258 (from EEG in Wikipedia).
5. Sacks, *Musicophilia,* 9–10.
6. G. J. Rose, *Psychoanalysis, Music, Art and Neuroscience* (New York: Brunner-Routledge, 2004), 1.
7. Daniel Levitin, "Music Makes Your Brain Happy," www.wired.com/medtech/health/news/2006/08/71631. Dr. Levitin runs the Laboratory for Music Perception, Cognition, and Expertise at McGill University in Montreal, Canada.
8. Thaut, *Rhythm, Music and the Brain,* 126.
9. Presentation of Neural Substrates of Processing Syntax and Semantics in Music (www.stefan-koelsch.de). In Haas and Brandes, *Music that works,* 151.
10. "Clinical Applications of Music Therapy in Neurological Rehabilitation." In Haas and Brandes, *Music that works,* 215.
11. www.musicianbrain.com.
12. J. Plantinga, and L. J. Trainor, "Melody Recognition by Two-Month-Old Infants," *Journal of the Acoustical Society of America* 123 EL (2009), 58–62 (http://psycserv.mcmaster.ca/ljt).
13. A. D. Patel, J. R. Iverson, M. R. Bregman, and I. Schulz, "Experimental Evidence for Synchronization to a Musical Beat in a Nonhuman Animal," *Current Biology* 19 (2009): 827–30 (http://vesicle.nsl.edu/users/patel).
14. I. Peretz, "Towards a Neurobiology of Musical Emotions," in *Handbook of Music and Emotion: Theory, Research, Applications,* ed. P. Juslin and J. Sloboda. (Oxford: Oxford University Press, 2010) (www.brams.umontreal.ca/plab).
15. Beck, "Key for Unlocking Memories."
16. J. Warren, "How Does the Brain Process Music?" *Clinical Medicine, Journal of the Royal College of Physicians* 1 (February 8, 2009): 32–36. Additional resource of note: "New Research Explores How—and Why—Music Affects Our Brains," *Scientific American,* July 6, 2009.

CHAPTER 9. MUSIC AND SOUND IN YOUR LIFE

1. *The Wall Street Journal,* January 14, 1998.
2. Tomatis, *Conscious Ear,* 144.
3. Nikki Landre, "Keys to Successful Music Lessons," *Discover* (October 1996): 100.

4. *San Francisco Chronicle,* November 9, 1998.
5. James Shreeve, "Music of the Hemispheres," *Discover* (October 1996).
6. Felicity Hicks, "The Role of Music Therapy in the Care of the Newborn," *Nursing Times* 91, no. 38 (1995): 31–33.
7. "Music for Medical Indications in the Neonatal Period: A Systematic Review of Randomized Controlled Trials," *Archives of Disease in Childhood—Fetal and Neonatal Edition* 94 (2009): F349–F354.
8. S. Amon, and others, "Live Music is Beneficial to Preterm Infants in the Neonatal Intensive Care Unit Environment," *Birth,* 33, no. 2 (June 2006): 131–36.
9. N. M. Weinberger, "Elevator Music: More Than It Seems," *MuSica* 2, no. 2 (Fall 1995): 1–5.
10. Peter Ostwald, "Music and Human Emotions," *Journal of Music Therapy* 3 (1966): 93–94.
11. J. H. Appleton, "Epilogue: Implications for Contemporary Music Practice," in *Psychology and Music: The Understanding of Melody and Rhythm,* ed. T. J. Tighe, and W. J. Dowling (Hillsdale, N.J.: Lawrence Erlebaum, 1993), 215–19.
12. Weinberger, "Elevator Music," 3.
13. Cathy H. McKinney, F. Tims, A. Kumar, and M. Kumar, "The Effect of Selected Classical Music and Spontaneous Imagery on Plasma B-Endorphin," *Journal of Behavioral Medicine* 20, no. 1 (1997): 85–99.
14. A highly practiced therapeutic approach that employs guided imagery is known as GIM, an acronym for Guided Imagery and Music. Created by Helen Bonny, GIM uses specially programmed classical music to generate a dynamic unfolding of inner experiences.
15. Ballard and Coates, "The Immediate Effects of Homicidal, Suicidal, and Nonviolent Heavy Metal and Rap Songs" quoted in Brown and Hendee, "Adolescents and Their Music," 1659 (see following note).
16. Elizabeth F. Brown and William R. Hendee, "Adolescents and Their Music: Insights into the Health of Adolescents," *Journal of the American Medical Association* 262, no. 12 (1989): 1659–63.
17. Marty Munson and Therese Walsh, "Soothing Sounds: Even Raucous Tunes May Be Relaxing," *Health Front Journal: Prevention* 47, no. 10 (October 1995): 42–44.
18. B. Bittman, and others. "Recreational Music-Making Modulates the Human Stress Response: A Preliminary Individualized Gene Expression Strategy," *Medical Science Monitor* 2 (February 11, 2005): BR31–40.
19. Dr. Laurel Trainor and colleagues presented their results at the Acoustical Society of America, November 2009.
20. *The Atlantic Monthly,* October 23, 2009. http://correspondents.theatlantic.com/lane_wallace/2009/10new_notes_on_the_uses_of_music.php.

21. Studies conducted by psychologist Frances Rauscher, currently of the University of Wisconsin at Oshkosh. Rauscher was a co-researcher at the University of California, Irvine, with Gordon Shaw and Katherine Ky. Together they launched the Mozart Effect studies in 1993. These seminal studies, reported in *Discover*, suggest that listening to music (specifically Mozart) temporarily enhances the brain's ability to perform abstract operations. The preschool study discussed here was published by the University of California, Irvine (*Omni,* Winter 1995).
22. Research conducted by neuroscientist Anne Blood, McGill University, Montreal, Canada.
23. Research conducted by Lawrence Parsons, University of Texas, San Antonio.
24. Research conducted by Dr. Gottfried Schlaug, Beth Israel Deaconess Medical Center, Boston, Massachusetts.
25. Research conducted by Lawrence Parsons, University of Texas, San Antonio.
26. Studies conducted in 1993 by psychologist Frances Rauscher, Gordon Shaw, and Katherine Ky at the University of California, Irvine, and reported in *Discover.*
27. F. H. Rauscher and G. L. Shaw, "Key Components of the Mozart Effect," *Perceptual and Motor Skills* 86, no. 3 (June 1998): 835–41.
28. In 2001, the *Sound Health Series* catalogue was purchased by Advanced Brain Technologies for distribution into the therapeutic and allied markets. Used as a complement to other neurodevelopmental treatments, the *Sound Health Series* is widely used in clinics and classrooms around the world.
29. *Times Online,* May 23, 2009, http://women.timesonline.co.uk/tol/life_and_style/women/diet_and_fitness/article6336553.ece.
30. Research conducted by Raymond Hull, Wichita State University, Kansas, and reported in the *New York Times,* June 21, 1998.
31. Arenofsky, "Headphones and Working Out," 22–24.
32. Medical and Sports Music Institute of America, *The Washington Post,* February 5, 1991.
33. Research conducted by Greg R. Oldham, organizational behaviorist and professor of business administration at the University of Illinois at Urbana-Champaign, and reported in the *Journal of Applied Psychology* (October 1995).
34. Research conducted in 1996 by Joseph Ribak, Occupational Health and Rehabilitation Institute at Loewenstein Hospital and Tel-Aviv University.
35. Research conducted by Stephen A. Falk, M.D., and Nancy F. Woods, National Institute of Environmental Health Sciences, Research Triangle Park, North Carolina, and Duke University School of Nursing, Durham, North Carolina, and reported in the *New England Journal of Medicine* (October 11, 1973).
36. The *New York Times,* August 22, 1993.
37. *Ottawa Citizen,* Ontario, Canada, May 13, 2009.

38. Donna Duvall and Alan Booth, "The Housing Environment and Women's Health," *Journal of Health and Social Behavior* (December 1979): 410–17.
39. Susan L. Staples, "Human Response to Environmental Noise," *American Psychologist* 51, no. 2 (February 1996): 143–50.
40. Luciano Bernardi, and others. "Effect of Rosary Prayer and Yoga Mantras on Autonomic Cardiovascular Rhythms: Comparative Study," *British Medical Journal* 323 (2001): 1446–49.
41. Luciano Bernardi, and others. Circulation, 119 (2009) 3171–3180. Full abstract and text: http://circ.ahajournals.org/cgi/content/abstract/119/25/3171.
42. L. Bernardi, C. Porta, and P. Sleight, "Cardiovascular, Cerebrovascular, and Respiratory Changes Induced by Different Types of Music in Musicians and Non-Musicians: The Importance of Silence," *Heart* 92 (2006): 445–52. doi: 10.1136/hrt.2005.064600. Full abstract and text: http:heart.bmj.com.
43. Bernardi et al., "Effect of Rosary Prayer," 1446–49.
44. P. D. Larsen and D. C. Galletly, "The Sound of Silence is Music to the Heart," *Heart* 2 (2006), 433–34, doi: 10.1136/hrt.2005.071902.
45. Falk and Woods, "Hospital Noise Levels and Potential Health Hazards."
46. Fred Schwartz, M.D., "Music as Anesthesia," in *Sonic Alchemy,* 97–100.
47. G. W. Grumet, "Pandemonium in the Modern Hospital," *New England Journal of Medicine* (February 1993): 328.
48. McKinney et al., "Effect of Selected Classical Music," 85–99.

CHAPTER 10. PROGRESSIVE SOUND HEALTH FOR THE HOSPITAL ENVIRONMENT

1. Great appreciation for the clear articulation regarding therapeutic musicians to Barbara Crowe, Melinda Gardiner, and Christina Tourin.
2. Therese Schroeder-Sheker founded the Chalice of Repose Project in 1979, the first music-thanatology organization in the world. Music-thanatology is a contemplative practice and a palliative medical modality with its own history, curriculum, lexicon of terms, publications, clinical focus, competencies and proficiencies, and scope of practice. Music-thanatology is a discipline and currently involves a very rigorous three-year graduate-level formation and education, with clinical internship and clinical residency programs nationwide (www.chaliceofrepose.org).
3. The International Harp Therapy Program (IHTP) was founded in 1994 and is a resonance-based interactive program focusing on harp and voice. Their motto is to have "a harp player for every hospice and hospital by 2020!" IHTP offers courses in Asia, Canada, The United Kingdom, Europe, and Australia. Their curriculum is two-thirds on-line study and one-third attendance required in each student's country or region (www.harprealm.com).

4. The Music for Healing and Transitions Program (MHTP) began in 1994. MHTP is offered at fourteen training sites nationwide, and is open to vocalists and instrumentalists. MHTP teaches the art of unconditional presence, combined with individually tailored, live therapeutic music based on the sciences of entrainment and resonance (www.mhtp.org).
5. www.therapeuticmusician.com.
6. Crowe, *Music And Soul Making.*
7. Wikipedia.
8. Matthew Gurewitsch, "Composing Concertos in the Key of Rx," the *New York Times,* March 29, 2009.
9. Haas and Brandes, *Music that works.*
10. Ibid., 83.
11. Individualized Music-focused Audio Therapies (I-MAT).
12. V. M. Brandes and others, "Receptive Music Therapy for the Treatment of Depression," twentieth World Congress for Psychosomatic Medicine, Torino, Italy, September 26, 2009, *Panminerva Medica* 51, suppl. 1–3 (2009): 13; "Music Programs Designed to Remedy Burnout Symptoms Show Significant Effects," *The Neuroscience and Music III: Disorders and Placicity Ann,* 69 (July 11, 2009): 422–25.
13. Gurewitcsh, "Composing Concertos."

CHAPTER 11. ANIMALS AND SOUND

1. BBC News, July 30, 2009, http://news.bbc.co.uk/go/pr/fr/-/earth/hi/earth_news/newsid_8174000/8174534.stm.
2. Wells, Graham, and Hepper, "The Influence of Auditory Stimulation on the Behaviour of Dogs Housed in a Rescue Shelter," *Animal Welfare* 11 no. 4: 385–93.
3. Sonar (sound navigation and ranging) is used to measure the presence and location of a submerged object. Sonar is the use of sonic and ultrasonic waves that, when reflected back, measure the distance from the sound source to an object.
4. Patricia B. McConnell, "The Whistle Heard Round the World," *Natural History,* October 1992, 51–58.
5. Information about Patricia McConnell, Ph.D., can be found at PatriciaMcconnell.com.
6. Susan Wagner, DVM, of Columbus, Ohio, is a respected veterinary neurologist whose current work emphasizes the importance of the human-animal bond. Dr. Wagner practices and teaches veterinary integrative medicine and is an adjunct faculty member at the Ohio State University Veterinary College.
7. Dr. Jaak Panksepp is the author of nine books and more than three hundred scientific articles, www.vetmed.wsu.edu/depts-vcapp/people/Panksepp-endowed.asp.
8. Grandin and Johnson, *Animals in Translation,* Orlando: Mifflin Harcourt Publishing, 2009).

9. Grandin and Johnson, *Animals Make Us Human,* 123.
10. Ibid., 5.
11. Ibid.
12. Ibid., 6.
13. Ibid., 23. Dr. Grandin defines stereotypes as "abnormal behaviors that are repetitive, invariant, and seemingly pointless."
14. Leeds and Wagner, *Through a Dog's Ear.* Used by kind permission of the publisher.
15. Wells et al., "The Influence of Auditory Stimulation," 385–93.
16. Wagner and others. "BioAcoustic Research & Development Canine Research Summary" (unpublished, 2006).
17. Leeds and Wagner, *Through a Dog's Ear,* chap. 7. Used by kind permission of the publisher.

CHAPTER 12. CURRENT SONIC MEDIA

1. Levitin, *This Is Your Brain on Music,* 7.

CHAPTER 13. A MATTER OF DISTINCTIONS

1. N. M. Weineberger, "Music Research at the Turn of the Millennium," *MuSica 5,* no. 3 (Fall 1999): 9.
2. Ibid., 5.
3. McClellan, *The Healing Forces of Music,* 181.

CHAPTER 14. THE BUILDING BLOCKS OF THERAPEUTIC SOUND

1. *Essential Dictionary of Music* (Los Angeles: Alfred Publishing, 1966), 92.
2. Gardner, *Sounding the Inner Landscape,* 128.
3. Gaynor, *Sounds of Healing,* 46.
4. Ibid., 25.
5. Goldman, *Healing Sounds* (Rochester, Vt.: Healing Arts Press, 2002), 33.
6. Gardner, *Sounding the Inner Landscape,* 218–19.
7. Goldman, *Healing Sounds,* 35.
8. Gardner, *Sounding the Inner Landscape,* 220.
9. Goldman, *Healing Sounds,* 38.

CHAPTER 15. SONIC NEUROTECHNOLOGIES

1. Carlson, *Psysiology of Behavior,* 2.
2. Alfred Tomatis, interview in *About the Tomatis Method,* 210.
3. Valerie DeJean, "All Listening Is Not the Same: Exposing Tomatis-Based Therapies and Other Knock-offs," www.Tomatis.net/67.80.203.99:98.
4. Sollier, *Listening for Wellness.*

5. Madaule, the founder of the Tomatis Listening Centre in Toronto, has created at-home exercises to support auditory health that he calls "Earobics." *Madule When Listening Comes Alive,* 155.
6. The Listening Program (original kit) designed by Dr. Ron Minson, has been replaced by newer editions created by Advanced Brain Technologies (ABT). Further information can be found at www.TheListeningProgram.com.
7. Further information regarding Dynamtic Listening Systems can be found by going to www.PowerListeningCenter.com.
8. Ostrander and Schroeder, *Superlearning 2000,* 103.
9. Thompson and Andrews, "Emerging Field of Sound Training," 95–96.
10. Ibid., 90.
11. Oster, "Auditory Beats in the Brain," 96.
12. F. Holmes Atwater, *The Hemi-Sync Process* (Faber, Va.: Research Division, The Monroe Institute, 1999), 2–3.
13. Ibid., 95.
14. 440 Hz corresponds to the A above middle C on the piano and is the note that orchestras tune to.
15. Suzanne Evans Morris, Ph.D., is a speech-language pathologist in private practice near Charlottesville, Virginia. With more than thirty-five years of clinical experience, she is internationally known for her work in identifying and treating young children with prespeech and feeding disorders. She has studied neurodevelopmental treatment approaches extensively and is a speech instructor for the Neurodevelopment Treatment Association. An advocate of therapeutic auditory programs, she is an active member of the professional division of The Monroe Institute.
16. The Monroe Institute has worked with some three thousand test subjects in a controlled laboratory setting. Each of these test subjects had a minimum of twenty individual tests. This gives The Monroe Institute a test base of more than sixty thousand tests.
17. Morris points out that frontal lobe synchronization is not the only effect of Hemi-Sync. "TMI's lab work has focused a lot on synchronization in these areas because of their interest in more expanded states of consciousness. However, their brain mapping studies also have shown synchronization in many other areas. In addition, I see a very clear influence of Hemi-Sync with infants and young kids whose frontal lobes aren't even functional yet from a neuroanatomical/neurophysiological perspective."
18. Hutchison, *Mega Brain Power,* 62–63.
19. Wise, *High Performance Mind,* 3.
20. Oster, "Auditory Beats in the Brain," 94–102.
21. R. Swann and others. *The Brain—A User's Manual* (New York: G. P. Putnam's Sons, 1982), 92.
22. The Monroe Institute, a nonprofit research, educational, membership-based organiza-

tion, is devoted to the exploration of methods of accelerated learning through practical explorations and coordinated research efforts using an interdisciplinary approach.

23. Leslie France, "What Is Hemi-Sync?" *Focus* (Fall 1990): 9.
24. The four major brain wave states are as follows: Beta waves (13–22 Hz) are found in our normal, waking state of consciousness. One is alert with a focus on the everyday activities of the world. Alpha waves (8–12 Hz) accompany states of relaxed wakefulness, such as daydreaming and meditation. Alpha waves are blocked by sensory awareness, conceptual thinking, and strong emotions. Theta waves (4–7 Hz) are found in states of high creativity, very deep meditation, and as one drifts to sleep. Delta waves (0.5–3.5 Hz) are found in the deepest part of the sleep cycle and in unconsciousness.
25. France, "What Is Hemi-Sync?" 8.
26. Robert Monroe lived from 1915 to 1995.
27. As of 2008, it is estimated that 150 million iPods have been sold internationally, see www.mlearninghub.com/ipod_sales.htlm.
28. A great resource for vibroacoustic research can be found on the LifeSounds website of soundworker Chris Brewer: www.musicinhealth.net/about_vibroacoustics.html.
29. (1935–2009), www.drpeterguymanners.com.
30. Olav Skille, http://quadrillo.tripod.com.
31. Hutchison, *Mega Brain,* 111.
32. George Patrick, "The Effects of Vibroacoustic Music on Symptom Reduction," *Engineering in Medicine and Biology* 18, no. 2 (March–April 1999): 97–100.
33. Hutchison, *Mega Brain,* 110.
34. Lane and others, "Binaural Auditory Beats Affect Vigilance, Performance, and Mood," 249–52.

CHAPTER 16. APPLIED PSYCHOACOUSTICS FOR HEALTH CARE PRACTITIONERS

1. P. Kliempt and others. "Hemispheric-Synchronization during Anaesthesia," *Anaesthesia* 54, no. 8 (1999): 760–73.
2. Dodd, *Turning the Blues to Gold,* back cover.

CHAPTER 17. ADVANCED SOUND TOOLS AND TECHNIQUES

1. Excerpts used by the kind permission of The Davis Center.
2. The work that Dorinne Davis is doing with otoacoustic emissions is fascinating! A copy of her research in this area can be found at www.ThePowerOfSound.com/DorinneDavisAddendum.
3. Beaulieu, *Music and Sound in the Healing Arts.*
4. www.BioSonics.com.

5. The icosahedron relates elementally to water. Sound travels four times faster in water than in air. The icosahedron is one of the five Platonic solids, based on the polyhedron, specifically the pentagram, which is also representative of a musical fifth. It links back to the Pythagoreans and is connected to the golden ratio. It was considered to be a sacred shape by Plato, the ancient Greeks, Johannes Kepler, and many of the mystery traditions throughout time.
6. For detailed information on the Acutonics planetary tuning forks, visit www.acutonics.com.
7. Although we had been cautioned about the inherent problems we might encounter, our level of productivity exceeded every estimate in size of plants, plant leaves, fruit, and total harvest and the longevity of production. Although we need to conduct specific, focused experiments in pest management—a significant problem with indoor growing.
8. http://en.wikipedia.org/wiki/Ultrasound.
9. www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2676802.
10. www.hifu.ca/physician/about_hifu.php.
11. Omar Ford, "Researchers Find HIFU Suitable for Brain Surgery Procedures," *Medical Device Daily* 13.154 (2009): 1–9.
12. Physical Acoustics Laboratory at Boston University, http://-paclab.bu.edu/index.html.
13. Ibid.
14. http://soundvitality.com.
15. http://en.wikipedia.org/wiki/Infrasound.
16. The work of John Reid and Erik Larson can be explored at www.cymatics.org.uk.
17. Lauterwasser, *Water Sound Images.*
18. P. G. Manners, *Techniques and Theories for the Emerging Pattern of Current Research* (Bretforton, Vale of Worcestershire, U.K.: Bretforton Hall Clinic, n.d.).
19. The Cyma1000E.
20. For further information on the work of John Stuart Reid and Erik Larson, go to: www.cymascope.com/cyma_research.
21. Haim and Sharon Freeman. "Bone Conduction Experiments in Humans—a Fluid Pathway from Bone to Ear." *Hearing Research* 146 (2000): 81–88.
22. Haim Sohmer and Sharon Freeman, "Further Evidence for a Fluid Pathway During Bone Conduction auditory stimulation," *Hearing Research* 189 (2004): 105–10.
23. G. Michael Halmagyi and others. "Vestibular Responses to Sound," *Annals of the New York Academy of Sciences* 1039 (2005): 54–67.
24. Nishimura Tadashi et al., "Effect of Stimulus Duration for Bone-Conducted Ultrasound on N1m in Man," *Neuroscience Letters* 327 (2002): 119–22.
25. Thaut, *Rhythm, Music, and the Brain,* 116.
26. Michael Thaut, *Training Manual for Neurologic Music Therapy* (Fort Collins, Colo.:

Colorado State University, 1999), http://homepages.wmich.edu/~eroth/NMT%20Overview.pdf.

27. Descriptions of RAS courtesy of NRRL, www.nrrl.cahs.colostate.edu.
28. Jeff Strong, "A Look at Rhythmic Entrainment Intervention by Its Creator," *S.I. Focus Magazine,* Winter 2008.
29. Per Wikipedia, electroencephalography (EEG) is the recording of electrical activity along the scalp produced by the firing of neurons within the brain.
30. www.encephalophonia.com/en/technology.htm.
31. In addition to her private practice, Dr Mindlin is an assistant clinical professor of psychiatry at Columbia University, College of Physicians and Surgeons, and supervising attending physician at the Department of Psychiatry, St. Luke's Roosevelt Hospital Center.
32. www.msnbc.msn.com/id/15731102/.
33. Melinda Beck, "A Key for Unlocking Memories," *The Wall Street Journal,* November 16, 2009.

CHAPTER 18. THE ANATOMY OF PSYCHOACOUSTIC MUSIC CREATION

1. The album was titled *Safe Passage: Affirming Songs of Hope and Healing* (Sausalito, Calif.: InnerSong Press, 1991).
2. "Human Brain Resonates to Music," *San Francisco Chronicle,* Nov. 9, 1998.
3. This example from The Listening Program (classic edition) does not include the filtration and gating processing that is actually found on the program. It was included on the enclosed CD for dynamic panning, nature, and rhythmic contour examples only. An edited version of this piece is found on the Sound Health Series album *Motivation.*

CHAPTER 19. THE SOUND AND MUSIC ALLIANCE (SAMA)

1. *Scientific American* (November 2004).
2. Hass and Brandes, *Music that works,* 178. The relationships between rhythms in biological systems and music were first described by J. Struthius.

EPILOGUE

1. Information regarding the Noise Pollution Clearinghouse can be found in the "Soundwork Resources" section of this book.

Bibliography

Beaulieu, John. *Human Tuning: Sound Healing with Tuning Forks.* BioSonic Enterprises, Ltd., 2010.

Bekoff, Marc. *The Emotional Lives of Animals.* Novato, Calif.: New World Library, 2007.

Bentov, Itzhak. *Stalking the Wild Pendulum: On the Mechanics of Consciousness.* Rochester, Vt.: Destiny Books, 1988.

Berendt, Joachim-Ernst. *Nada Brahma: The World Is Sound.* Rochester, Vt.: Destiny Books, 1987.

Brewer, Chris, and Don Campbell. *Rhythms of Learning: Creative Tools for Developing Lifelong Skills.* Tucson, Ariz.: Zephyr Press, 1991.

Brewer, Chris Boyd. *Soundtracks for Learning: Using Music in the Classroom.* Bellingham, Wash.: LifeSounds Educational Services, 2009.

Buchanan, Gary Robert. *Sona: Healing with Wave Front BIOresonance.* Reno, Nev.: Gary Robert Buchanan & The Music Guild, 2008.

Campbell, Don. *Music: Physician for Times to Come.* Wheaton, Ill.: Quest Books, 1991.

———. *The Mozart Effect for Children.* New York: Morrow, 2000.

———. *The Mozart Effect: Tapping the Power of Music to Heal the Body.* New York: Avon Books, 1997.

Campbell, Don, and Alex Doman. *Healing at the Speed of Sound.* New York: Hudson Street Press, 2011.

Carey, Donna, and Marjorie de Muynck. *There's No Place Like Ohm.* Llano, N. Mex.: Devachan Press, 2002–2007.

Carlson, Neil R. *Physiology of Behavior.* Boston: Allyn and Bacon, 1994.

Clynes, Manfred. *Music, Mind, and Brain: The Neuropsychology of Music.* New York: Plenum Press, 1982.

Cole, K. C. *Sympathetic Vibrations: Reflections on Physics as a Way of Life.* New York: Bantam, 1984.

Cook, Pat Moffitt. *Music Healers of Indigenous Cultures.* Bainbridge, Wash.: Open Ear Press, 1997 and 2004.

Crowe, Barbara. *Music and Soul Making.* Lanham, Md.: Scarecrow Press, 2004.

D'Angelo, James. *The Healing Power of the Human Voice: Mantras, Chants, and Seed Sounds for Health and Harmony.* Rochester, Vt.: Healing Arts Press, 2000.

Davis, Dorinne S. *Every Day a Miracle: Success Stories with Sound Therapy.* Landing, N.J.: Kalco Publishing, 2006.

———. *Sound Bodies through Sound Therapy.* Landing, N.J.: Kalco Publishing, 2004.

Dewhurst-Maddock, Olivea. *The Book of Sound Therapy: Heal Yourself with Music and Voice.* New York: Fireside/Simon & Schuster, 1993.

Dodd, Vickie. *Turning the Blues to Gold: Soundprints.* Boulder, Colo.: Wovenword Press, 1999.

Duffin, Ross W. *How Equal Temperament Ruined Harmony (and Why You Should Care).* New York: W. W. Norton & Company, 2007.

Flatischler, Reinhard. *The Forgotten Power of Rhythm.* Mendocino, Calif.: LifeRhythm, 1992.

———. "The Influence of Musical Rhythmicity in Internal Rhythmical Events." In *MusicMedicine,* edited by Ralph Spintge. St. Louis, Mo.: MMB Music, 1992.

Gardner, Kay. *Sounding the Inner Landscape; Music as Medicine.* Stonington, Maine: Caduceus Publications, 1990.

Gass, Robert. *Chanting: Discovering Spirit in Song.* New York: Broadway Books, 1999.

Gaynor, Mitchell. *Sounds of Healing.* New York: Broadway Books. 1999.

Goldman, Jonathan. "Sonic Entrainment." In *MusicMedicine,* edited by Ralph Spintge. St. Louis, Mo.: MMB Music, 1992.

———. "Sonic Entrainment." In *Music: Physician for Times to Come,* edited by Don Campbell. London: Quest Books, 1991.

———. *The 7 Secrets of Sound Healing.* Carlsbad, Calif.: Hay House, 2008.

Grandin, Temple, and Catherine Johnson. *Animals Make Us Human.* Orlando, Fla.: Houghton Mifflin Harcourt Publishing, 2009.

Hall, Donald E. *Musical Acoustics.* Belmont, Calif.: Wadsworth, 1980.

Haas, R., and V. Brandes eds. *Music that works.* Vienna: Springer-Verlag/Wien, 2009.

Hay, Louise L. *You Can Heal Your Life.* Santa Monica, Calif.: Hay House, 1984.

Helmholtz, Hermann. *On the Sensations of Tone as a Physiological Basis for the Theory of Music.* New York: Dover, 1885.

Hempton, Gordon, and John Grossmann. *One Square Inch of Silence: One Man s Search for Natural Silence in a Noisy World.* New York: Free Press, 2009.

Hewitt, Paul G. *Conceptual Physics.* 7th ed. New York: HarperCollins, 1993.

Hoffman, Janalea. *Rhythmic Medicine: Music with a Purpose.* Leawood, Kan.: Jamillan Press, 1995.

Hutchinson, Michael. *Mega Brain: New Tools and Techniques for Brain Growth and Mind Expansion.* New York: Ballantine Books, 1987.

———. *Mega Brain Power: Transform Your Life with Mind Machines and Brain Nutrients.* New York: Hyperion, 1994.

Joudry, Patricia. *Sound Therapy for the Walkman.* St. Denis, SK, Canada: Steele and Steele, 1984.

Jourdain, Robert. *Music, The Brain, and Ecstasy.* New York: Avon Books, 1997.

Kahn, Hazrat Inayat. *The Music of Life.* New Lebanon, N.Y.: Omega Publications, 1983.

Kenyon, Tom. *Brain States.* St. Petersburg, Fla.: United States Publishing, 1994.

Lauterwasser, Alexander. *Water Sound Images: The Creative Music of the Universe.* Newmarket, N.H.: Macromedia Publishing, 2006.

Leeds, Joshua. *Sonic Alchemy: Conversations with Leading Sound Practitioners.* Sausalito, Calif.: InnerSong Press, 1997.

Leeds, Joshua, and Susan Wagner. *Through a Dog's Ear.* Boulder, Colo.: Sounds True, 2008.

Le Mee, Katherine. *Chant: The Origins, Form, Practice, and Healing Power of Gregorian Chant.* New York: Bell Tower, 1994.

Leonard, George. *The Silent Pulse: A Search for the Perfect Rhythm that Exists in Each of Us.* New York: Dutton, 1978.

Levitin, Daniel J. *This Is Your Brain on Music: The Science of a Human Obsession.* New York: Dutton, 2006.

———. *The World in Six Songs: How the Musical Brain Created Human Nature.* New York: Dutton, 2008.

Lozanov, Georgi. *Suggestology and Outlines of Suggestopedy.* New York: Gordon and Breach Science Publishers, 1978.

Madaule, Paul. *When Listening Comes Alive.* Norval, ON, Canada: Moulin Publishing. 1993.

Maxfield, Melinda C. "The Journey of the Drum." *In Music and Miracles* edited by Don Campbell. Wheaton, Ill.: Quest Books, 1992.

McClellan, Randall. *The Healing Forces of Music.* Boston: Element, 1991.

McConnell, Patricia. *For the Love of a Dog: Understanding Emotion in You and Your Best Friend.* New York: Ballentine, 2005.

Newham, Paul. *The Singing Cure: An Introduction to Voice Movement Therapy.* Boston: Shambhala, 1994.

Oster, G. "Auditory Beats in the Brain." *Scientific American* 229 (1937): 94–102.

Ostrander, Sheila, and E. Schroeder. *Superlearning 2000.* New York: Delacorte Press, 1994.

Paul, Russill. *The Yoga of Sound.* Novato, Calif.: New World Library, 2004.

Redmond, Layne. *When the Drummers Were Women.* New York: Harmony, 1997.

Sacks, Oliver. *Musicophilia: Tales of Music and the Brain.* New York: Alfred A. Knopf, 2007.

Schafer, R. Murray. *The Soundscape.* Rochester, Vt.: Destiny Books, 1977.

Schneck, Dr. Daniel, and Judith K. Schneck, eds.. *Music in Human Adaptation.* St. Louis, Mo.: MMB Music, 1997.

Shaw, Gordon L. *Keeping Mozart in Mind.* San Diego: Academic Press, 2000.

Sollier, Pierre. *Listening for Wellness: An Introduction to the Tomatis Method.* Walnut Creek, Calif.: The Mozart Center Press, 2005.

Spintge, Ralph, ed. *MusicMedicine.* St. Louis, Mo.: MMB Music, 1992.

———. *Music Medicine,* Vol. 2. St. Louis, Mo.: MMB Music, 1996.

Stockhausen, Karlheinz. *Towards a Cosmic Music.* Dorset, UK: Element, 1989.

Tame, David. *The Secret Power of Music.* Rochester, Vt.: Destiny Books, 1984.

Thaut, Michael H. *Rhythm, Music, and the Brain: Scientific Foundations and Clinical Applications.* New York: Routledge, 2005.

Tomatis, Dr. Alfred, interview in *About the Tomatis Method,* edited by Billie Thompson, 209–25. Toronto: The Listening Centre Press, 1989.

———. *The Conscious Ear.* New York: Station Hill Press, 1991.

———. *The Ear and Language.* Norval, ON, Canada: Moulin Publishing, 1996.

Treasure, Julian. *Sound Business.* Gloucestershire, UK: Management Books, 2007.

Williams, SaraJane. *Good Vibrations: Principles of Vibroacoustic Harp Therapy.* Macungie, Pa.: Silva Vocat, 2005.

Wise, Anna. *The High Performance Mind: Mastering Brainwaves for Insight, Healing, and Creativity.* New York: Tarcher/Putnam, 1995.

About the Author

Joshua Leeds is a sound researcher, educator, and music producer. He specializes in the fields of *psychoacoustics,* the study of the effect of music and sound on the human nervous system, and *bioacoustics,* how human sound affects other living beings.

He is the author of three books, including *Through a Dog's Ear* and *Sonic Alchemy,* and multiple magazine and journal articles. His thirty-plus recordings are used in homes, clinics, classrooms, and animal-care facilities worldwide (see discography below).

He is the codirector of BioAcoustic Research & Development, furthering the understanding of the effect of music and sound on animals.

He is a founding director of the Sound and Music Alliance (SAMA), a nonprofit professional association advancing the intentional use of music and sound.

Further information about the author and his work is available at JoshuaLeeds.com.

ALSO BY JOSHUA LEEDS

Books

1997 *Sonic Alchemy: Conversations with Leading Sound Practitioners*

2001 *The Power of Sound: How to Manage Your Personal Soundscape for a Vital, Productive, & Healthy Life* (first edition)

2008 *Through a Dog's Ear: Using Sound to Improve the Health & Behavior of Your Canine Companion*

Discography

1986 *Songs of Affirmation* (with Louise L. Hay)

1987 *Gift of the Present* (with Louise L. Hay)

1989 *Rhapsody for Louise*
1991 *Safe Passage* (with Louise L. Hay)
1996 *Masterworks for Relaxation* (with the Monroe Institute)
1997 *Eight Meditations for Optimum Health* (with Andrew Weil, M.D.)
1997 *Sound Health/Concentration*
1997 *Sound Health/Learning*
1997 *A Baroque Garden for Concentration* (with the Monroe Institute)
1998 *Sound Body, Sound Mind: Music for Healing* (with Andrew Weil, M.D., and Anna Wise)
1998 *Sound Health/De-Stress*
1998 *Sound Health/Thinking*
1999 *Sound Health/Relax*
1999 *Sound Health/Productivity*
1999 *The Listening Program* (8-CD set)
2002 *Joyous Birth*
2003 *Essential Sound/Sound Asleep* (2-CD set) (with Anna Wise)
2004 *Essential Sound/Uplifting* (2-CD set)
2004 *Essential Sound/Calm* (2-CD set)
2005 *Essential Sound/Energy* (2-CD set)
2006 *Increase Vitality* (with Andrew Weil, M.D.)
2006 *Relax and De-Stress* (with Andrew Weil, M.D.)
2008 *Through a Dog's Ear/Calm Your Canine Companion*, Vol. 1
2008 *Through a Dog's Ear/Calm Your Canine Companion*, Vol. 2
2008 *Through a Dog's Ear/Music for the Canine Household,* Vol. 1
2008 *Through a Dog's Ear/Driving Edition*
2009 *Deep Calm* (with Andrew Weil, M.D.)
2009 *Hemi-Sync Support for Healing* (with the Monroe Institute)
2010 *ReSet: Tempo-Based Music for Transitions* (Therapeutic Series)
2011 *Through a Dog's Ear/Music for the Canine Household,* Vol. 2
2011 *Through a Dog's Ear/Calm Your Canine Companion*, Vol. 3